TECHNOLOGY DEPT.

POWER PLANT ENGINEERING

THE PLANT ENGINEERING AND MAINTENANCE MAGAZINE FOR EVERY INDUSTRY

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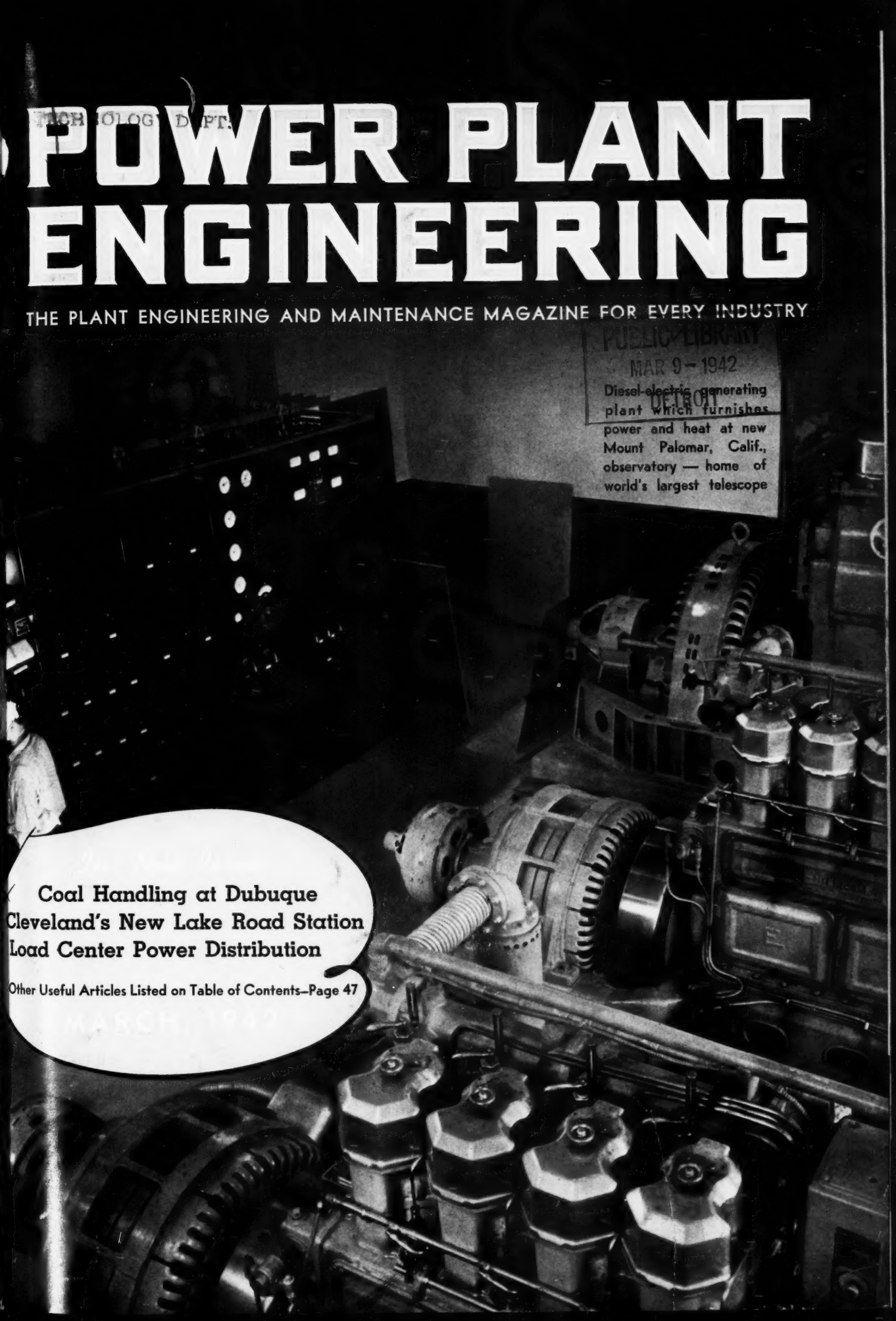
DETROIT



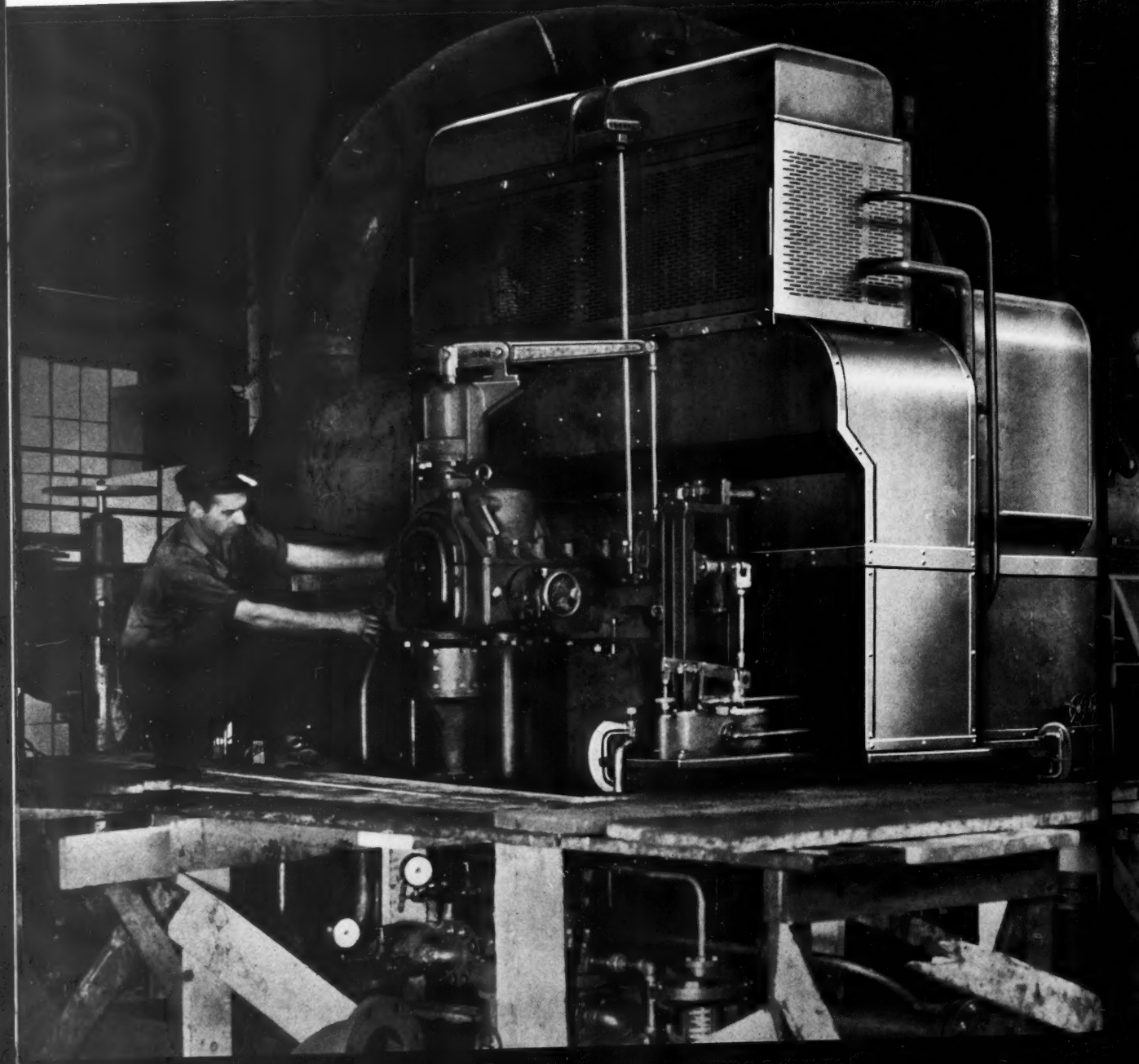
Diesel-electric generating plant which furnishes power and heat at new Mount Palomar, Calif., observatory — home of world's largest telescope

Coal Handling at Dubuque
Cleveland's New Lake Road Station
Load Center Power Distribution

Other Useful Articles Listed on Table of Contents–Page 47

MARCH 1942

POWER is the first...



ELLIOTT

...essential of VICTORY

HERE, on the test block, is a unit which symbolizes the guns, shells, bombs, tanks, planes and other equipment essential to ultimate victory. Here, about to be "sworn into service" is an Elliott Turbine-Generator, typical of many now helping to provide the driving power to win the war. Typical, also, in its sturdiness and dependability, of the Elliott deaerators, condensers, ejectors, motors, auxiliary drive turbines, and other equipment which are also serving to provide power to turn the wheels that make the things that will bring Victory.

Battles that are won in the field, must first be won on the factory floor, and before that, in the power plant. Elliott Company is proud to be helping to win the Battle of Power.

ELLIOTT COMPANY
Steam Turbine Department
JEANNETTE, PA.
District Offices in Principal Cities

H-656

POWER EQUIPMENT SERVES THE NATION

"Air Raid" Protection Inside a Diesel Engine

A "CORRECT" ANSWER TO THE PROBLEM OF OXIDATION IN DIESEL CRANKCASES:

Problem: The crankcase of a modern Diesel engine is a "torture chamber" for lubricating oil. As the oil escapes from the ends of the bearings, it is whipped into a fine mist by the racing crankshaft and rods. In this finely divided form, the oil is attacked from all sides by *hot air*. The constant churning and presence of impurities accelerate the tendency for oil to oxidize and form deposits.

Answer: To resist this terrific punishment, oil must have the greatest possible stability. It must be made from carefully selected crudes; refined with greatest skill. Backed by 76 years' experience, Socony-Vacuum has created "correct" oils for *every* type and size of Diesel engine.

Gargoyle D.T.E. Oils 1-to-5 are designed for maximum protection and stability in large and intermediate Diesels. *Delvac "500 Series" Oils* are specially made for small, high-speed engines.

TO HELP MAINTAIN CAPACITY PRODUCTION, CALL IN

SOCONY-VACUUM for "Correct Lubrication"

SOCONY-VACUUM OIL CO., INC. — Standard Oil of N. Y. Div. — White Star Div. Lubrite Div. — Chicago Div. — White Eagle Div. — Wadhams Div. — Southeastern Div. (Baltimore) — Magnolia Petroleum Company — General Petroleum Corporation of Calif.

GARGOYLE

Lubricants

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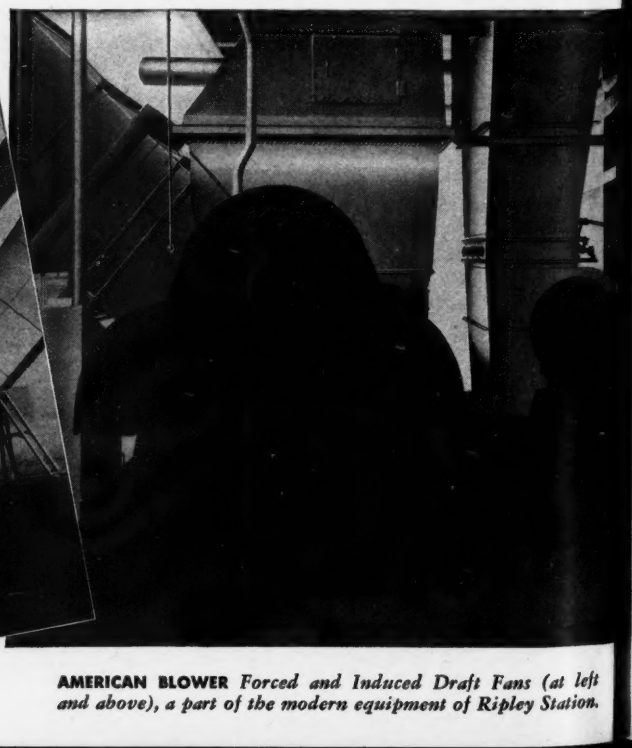
WICHITA

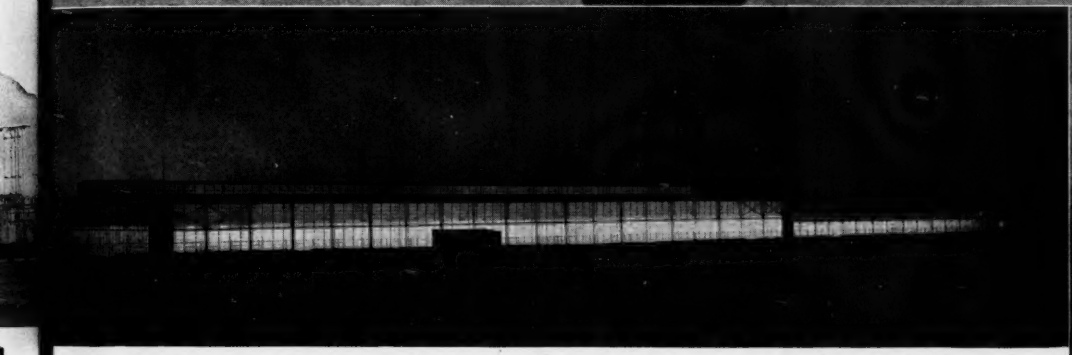
Keeps 'em

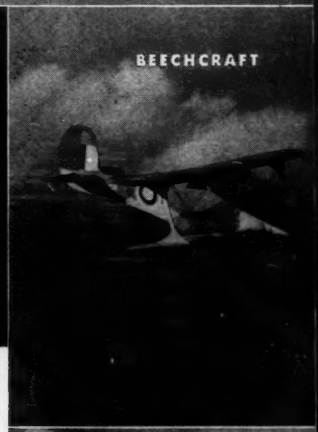
KANSAS GAS AND ELECTRIC COMPANY'S NEW RIPLEY STATION

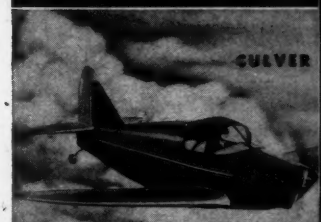


AMERICAN BLOWER *Forced and Induced Draft Fans (at left and above), a part of the modern equipment of Ripley Station.*

BOEING *training plane.*







PRODUCING *planes for victory, 24 hours a day—one of Wichita's many aircraft plants (above).*

Wichita, long a pacemaker for progress, is making a new name for itself! Already one of the "wheat capitals" of the nation — important, too, as a milling, oil refining, meat packing and dairy processing center — Wichita now has rolled up its sleeves to show the world how to "keep 'em flying." Four nationally known plane manufacturers have plants here — geared up to go. They've been "going great guns" a long time now. And the progressive Kansans operating these modern plants will tell you, "We've only started!"

Only by foresight and a background of progress can a city like Wichita move to the forefront with a new, complex industry in so short a time. The preparations date 'way back, and to the community as a whole belongs the credit.

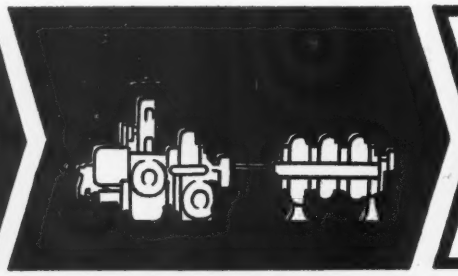
Among those who have had a vital part in Wichita's planning for progress are the men behind the Kansas Gas and Electric Company. Decades of progressive management, constant growth and expansion, lie behind the company's ability to serve the 916 industrial customers, as well as 8,524 commercial and 65,141 residential customers in its wide field of service. We of American Blower are proud to have served the Kansas Gas and Electric Company by supplying Forced and Induced Draft Fans for its modern plants. Have you a problem involving Mechanical Draft, Dust Collecting or Fluid (variable speed) Drive? Write the nearest American Blower branch office for complete data.

AMERICAN BLOWER

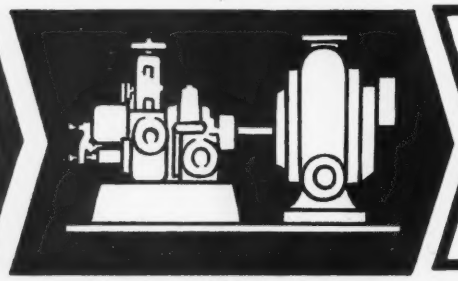
AMERICAN BLOWER CORPORATION, Detroit, Michigan
CANADIAN SIROCCO COMPANY, LIMITED, WINDSOR, ONTARIO
Division of American Radiator and Standard Sanitary Corporation

FACTS To Help You Select the RIGHT

BOILER FEED PUMPS

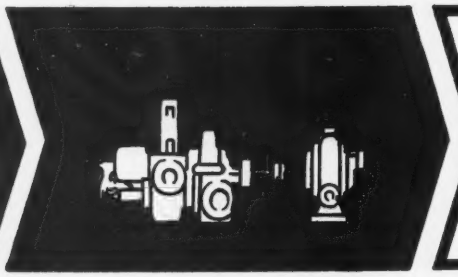


In selecting boiler feed-pump drives, continuity of service should be the first consideration. Type D variable-speed turbines with constant-pressure regulator (speed of the turbine automatically adjusted to maintain a constant discharge pressure from the pump) or with differential-pressure regulator (turbine speed automatically adjusted to maintain pump pressure at a predetermined pressure above boiler pressure) are recommended. Operation can be either condensing or noncondensing.

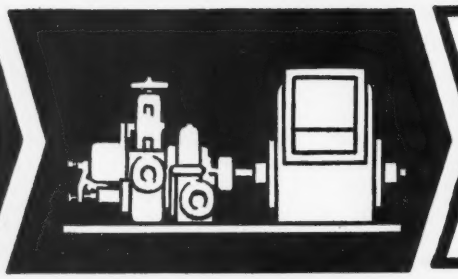


Constant-speed Type D turbines with reduction gears meet the severe, long-life requirements of power plant condenser duty. Turbine drives make possible prompt restoration of service after electrical disturbances because the vacuum in the condenser can be maintained.

HOT WELL AND CONDENSATE PUMPS

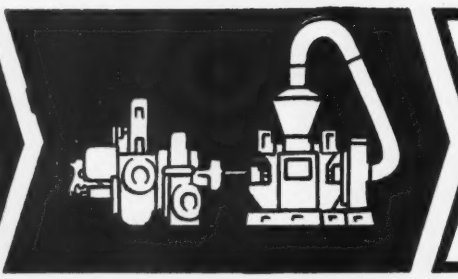


Where constant-speed drives are required, turbines offer inexpensive operation. High availability factor is assured because turbine operation depends only on a supply of steam. Operation may be either condensing or noncondensing.

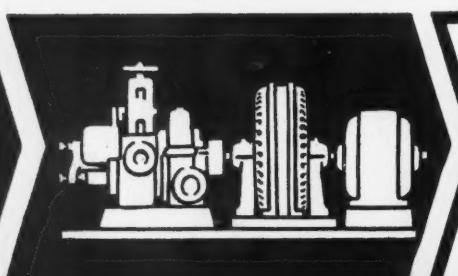


Continuity of operation should be the first consideration in all essential induced- or forced-draft fan drives. Variable speed and the ability to withstand high ambient temperatures are two primary reasons for selecting mechanical-drive turbines for this service. Combustion control is recommended for automatically controlling speed to obtain the best fuel-air ratio and draft.

COAL PULVERIZERS

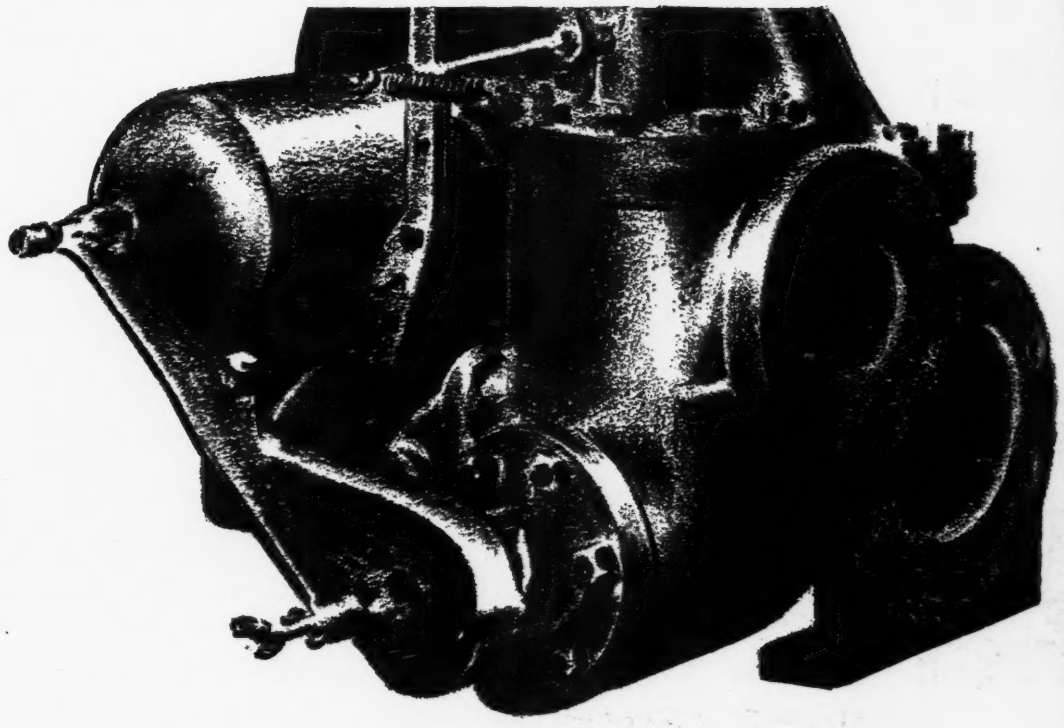


Constant-speed mechanical-drive turbines with inherent, high starting torque are correct for coal pulverizers. Turbines keep going even when adverse operating conditions exist, such as high ambient temperatures and dusty or abrasive atmospheres.



Mechanical-drive turbines assure continuity of service and a positive source of excitation for prime movers. Normally, the exciter is driven by the motor but when power is interrupted the turbine picks up the load automatically. Turbines will also divide the load with the motor to improve station heat balance.

TURBINE DRIVE for POWER-PLANT AUXILIARIES



IN OUR complete war effort, many power plants are being driven at rates that severely test the reliability of their auxiliary drives. Now, more than ever before, these drives should be so designed and built that they will withstand continuous, gruelling punishment. General Electric Type D mechanical-drive turbines provide a high degree of immunity from any difficulties that would jeopardize 24 hours-a-day, 7 days-a-week operation.

When the *right* drive is specified, power production can often be greatly simplified. Maintenance may be reduced. Over-all station economy, too, may be improved by taking full advantage of the mechanical-drive turbine's double dividend of heat and power. The now-better-than-ever Type D turbine has a strainer to prevent entrance of foreign materials, a combined trip and throttle valve to assure protection against overspeed, and ring-lubricated bearings with the oil supply insulated and cooled by circulating water. With these exclusive features, no wonder Type D's are finding their way into so many of the most efficient power plants in America.

If you are interested in heat balance, find out what Type D turbines can save by doing double duty—acting as reducing valves to provide clean, low-pressure steam for feed water heating and providing low-cost mechanical power for auxiliary drive.

Or, if you are primarily interested in protecting your plant against shutdowns, find out about the static and dynamic balancing of the rotor that minimizes wear on bearings and couplings, the chrome alloy buckets that resist corrosion and erosion, and the combined trip and throttle valve that can be reset in less than 10 seconds.

A G-E turbine specialist will gladly explain further the benefits of these features. Call him in today. You'll save time and money by following his practical recommendations. General Electric Company, Schenectady, N. Y.

IT TOOK TWO ATTEMPTS . .

. . . To Acquire the Right Steam Generating Equipment

HOW THE APPEAL OF A MORE ATTRACTIVE PRICE POSTPONED THE BEST SOLUTION OF THIS PLANT'S STEAM GENERATING PROBLEM

"Why pay more than we have to for this new equipment?" was the opinion that influenced a large eastern brewery when considering new boiler plant facilities several years ago. As a result, they turned down a C-E proposal that frankly was more expensive but was based on a careful study of steam demand, available fuels and other conditions in the plant. Instead, the customer decided in favor of an installation commended by a material saving that would have proved well worthwhile . . . were initial price the only consideration in the selection of economical steam generating equipment.

As is so frequently the sequel to such a buying decision, a brief period of service quickly changed the customer's viewpoint. Efficiency fell below expectations and maintenance was higher than anticipated. These differences materially affected the picture of return on investment and served to emphasize the true economic measure of steam generating equipment — overall costs of year-in and year-out operation.

Consequently, when steam plant expansion was again considered in 1939, C-E was given the opportunity of re-presenting its original proposal. This time the more expensive installation was purchased. It consisted of two C-E 4-drum Boilers (VA Type), both fired by C-E Coxe Traveling Grate Stokers . . . each unit with a capacity of about 30,000 lb of steam per hr. The installation is now two years old. The customer reports with enthusiasm that it has more than fulfilled original guarantees. Even this brief period of service provides ample evidence that it will prove a great deal more economical *in the long run.*

C-E PRODUCTS INCLUDE ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS, AND AIR HEA

COMBUSTION

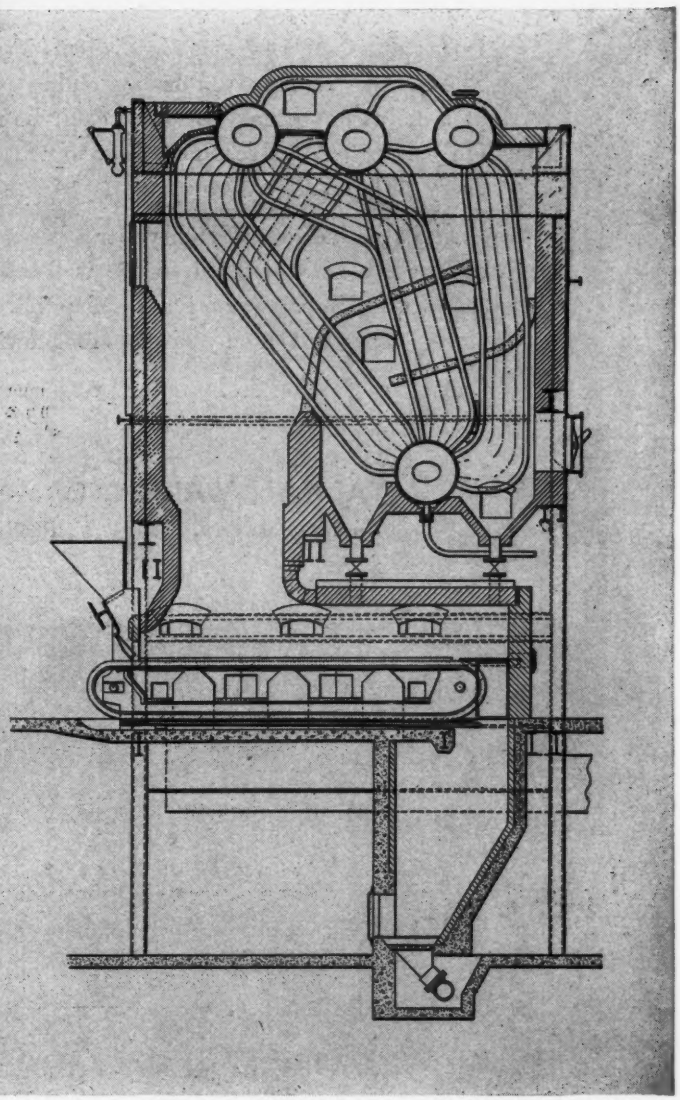
...and a Change of Viewpoint...

An Authentic Account of

COMBUSTION ENGINEERING'S

Service

(No. 13 of a series)



WHAT THIS MEANS TO YOU

The point of this story is not one of high *versus* low first-cost – for C-E frequently advises constructive cost-cutting where circumstances warrant. Its real significance is this: C-E has the experienced engineering skill to arrive at the one optimum solution to meet the particular combination of steam demand, fuel supply and other conditions existing for any job. Because C-E offers a complete line of steam generating equipment, it has the unprejudiced point of view toward alternative practices that eliminates the source of bias. Moreover, C-E has a reputation for long-run service satisfaction to protect, and every C-E proposal for steam generating equipment, large or small, simple or complex, must meet this standard.

Isn't it reasonable that you, too, will benefit by calling on C-E experience and equipment to meet your own needs for modern low-cost steam generation? A-636

COMBUSTION ENGINEERING COMPANY, INC., 200 MADISON AVENUE, NEW YORK, N.Y. • CANADA: COMBUSTION ENGINEERING CORPORATION, LTD., MONTREAL

ENGINEERING

52 Yarway Blow-Off Valves a

TWENTY YEARS of experience with Yarway Blow-Off Valves at the State University of Iowa has convinced their chief engineer that "Yarway Valves are the best blow-off valves on the market."

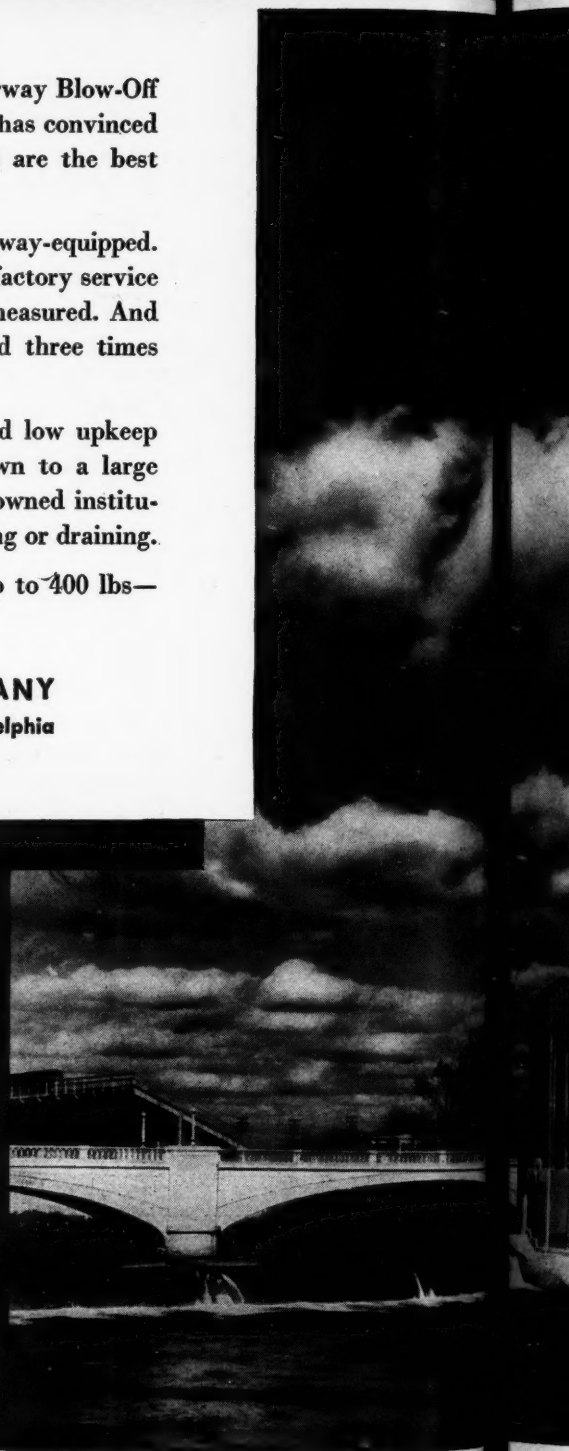
He states further—"This plant is 100% Yarway-equipped. The 52 valves have given us long and satisfactory service at a maintenance cost so low it can't be measured. And for years these valves have been operated three times every 24 hours."

The positive dependability, long life and low upkeep of Yarway Blow-Off Valves are well-known to a large majority of important private and public-owned institutions. They are equally suitable for blowing or draining.

Ask for Catalog No. 421 for pressure up to 400 lbs—No. 430 for higher pressures.

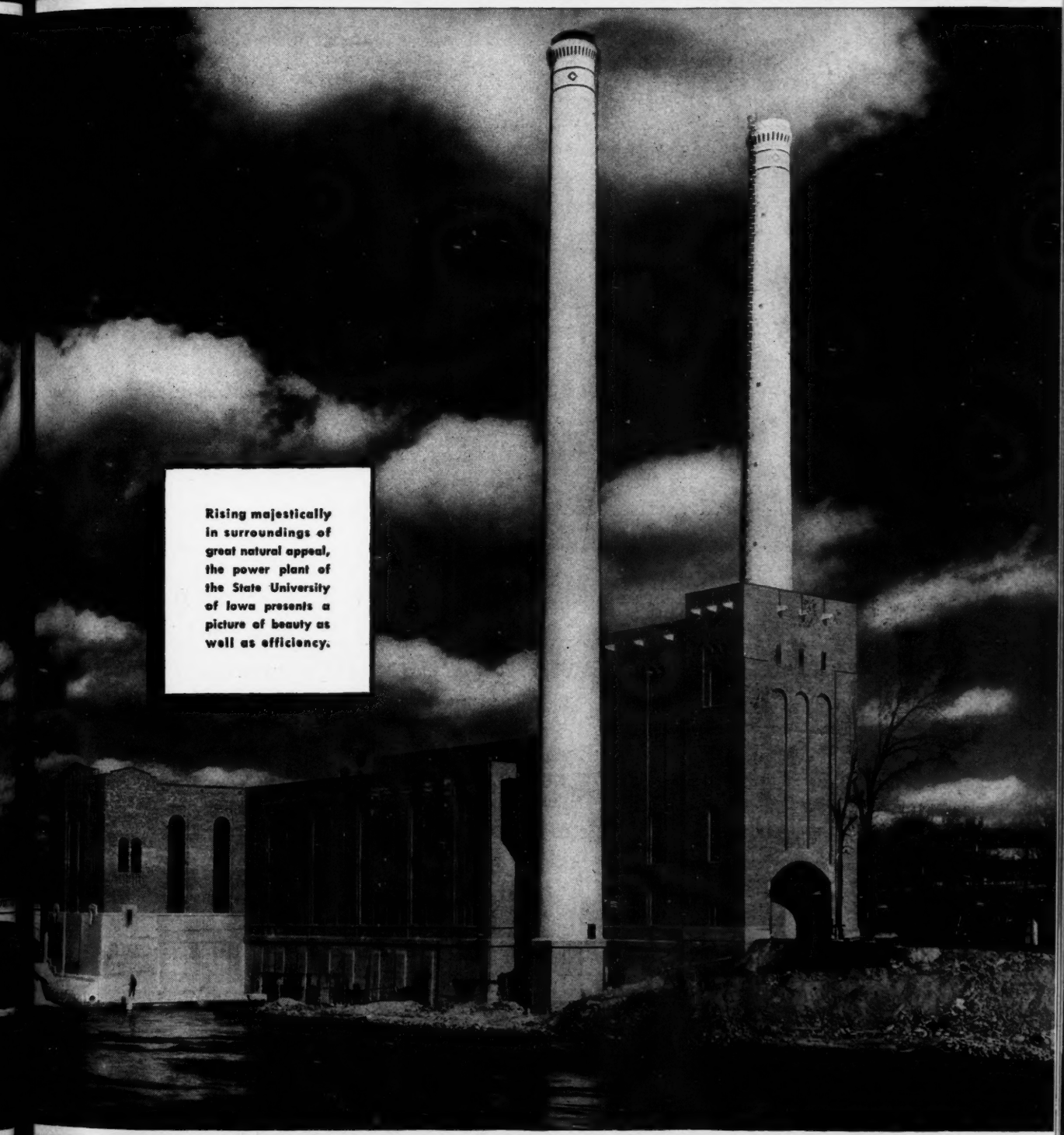
YARNALL-WARING COMPANY
114 Mermaid Ave. Philadelphia

View in the boiler room showing a few of the 52 Yarway Blow-Off Valves at Iowa State University.



YARWAY

at Iowa State University


Rising majestically in surroundings of great natural appeal, the power plant of the State University of Iowa presents a picture of beauty as well as efficiency.

BLOW-OFF VALVES

Look at the

Pioneers in inclined water walls...Pioneers in water-cooled stokers...Rely on the leader!

AS YOU set out to select modern firing equipment, note who it was that pioneered the introduction and major improvements of the multiple retort inclined underfeed stoker.

These same engineers originated stoker inclined side water walls. It is therefore only natural that they should be best qualified to develop and introduce the water-cooled stoker to fully satisfy demands for equipment which can burn the poorest or the highest grade coal with equal ease.

In *all* improvements, isn't it logical to expect the highest perfection from a 37 year experience devoted to coordinating stoker and furnace design into one increasingly efficient steam generating unit?

It is important to know all the facts! It is important to deal with the leader. Only so can you be assured of the utmost in equipment and service. Only so can your dollar be made to yield all that your power requirements demand. American Engineering Company, Aramingo Avenue, Philadelphia.

AMERICAN ENGINEERING

A-E-CO Taylor Stokers, Water Walls, Ash Hoppers, Hele-Shaw Fluid Power, Lo-Hed

Record!

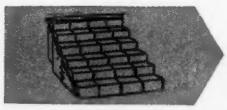
MILESTONES IN STOKER HISTORY

1937 "Noblo" Tuyere

Venturi-shaped passages provide self-limiting air flow, thus equalizing combustion rate over the entire stoker.

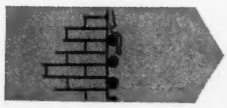
1934 Taylor Stoker, Water-Cooled

Burns *reliably* all grades of bituminous and semi-bituminous coal, of any analyses or ash fusion temperatures.



1930 Ducar Extension Grates

Refractory blocks provide exceptionally low maintenance with low sulphur coals.



1929 Slag Drip Feature

Slag drip feature of inclined side water walls causes molten slag to solidify; increases combustion rates.

1929 Straight Line Drive

Straight rather than angular thrust on rams reduces wear and permits individual adjustment of secondary coal pushers.

1926 Inclined Side Water Walls

Located at side of and immediately above stoker, provides cooling where most effective and where highly desirable.

1919 Multiple Retort Hydraulic Stoker

Coal-feeding rams are actuated by oil under pressure. No crankshafts, power boxes, gear trains or shearing pins.

1915 Power Operated Dump Plates

Power Operated Dump Plates permit ash removal from furnace in a few seconds and without manual labor.

1913 Moving Overfeed Section

Moving Overfeed Section breaks up clinker formations and burns out remaining combustible in the coal.

1904 Taylor Multiple Retort Stoker

The Taylor Multiple Retort Stoker, the original inclined retort underfeed stoker, was introduced in this year.

Write today for **FREE** literature giving more detailed information about A-E-CO Taylor Stokers.

THE A-E-CO Taylor Stoker

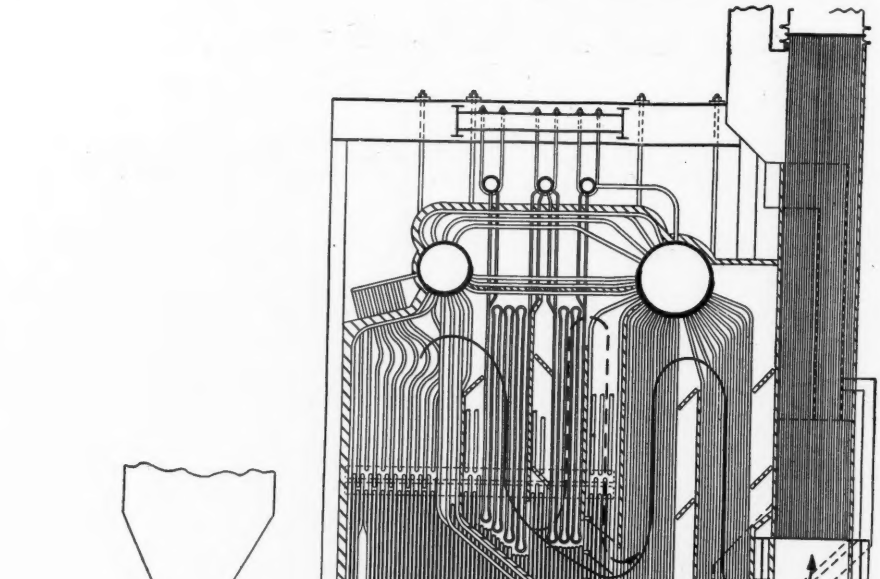
A-E-CO Water Walls

COMPANY

Hoists, Marine Deck Auxiliaries

City of

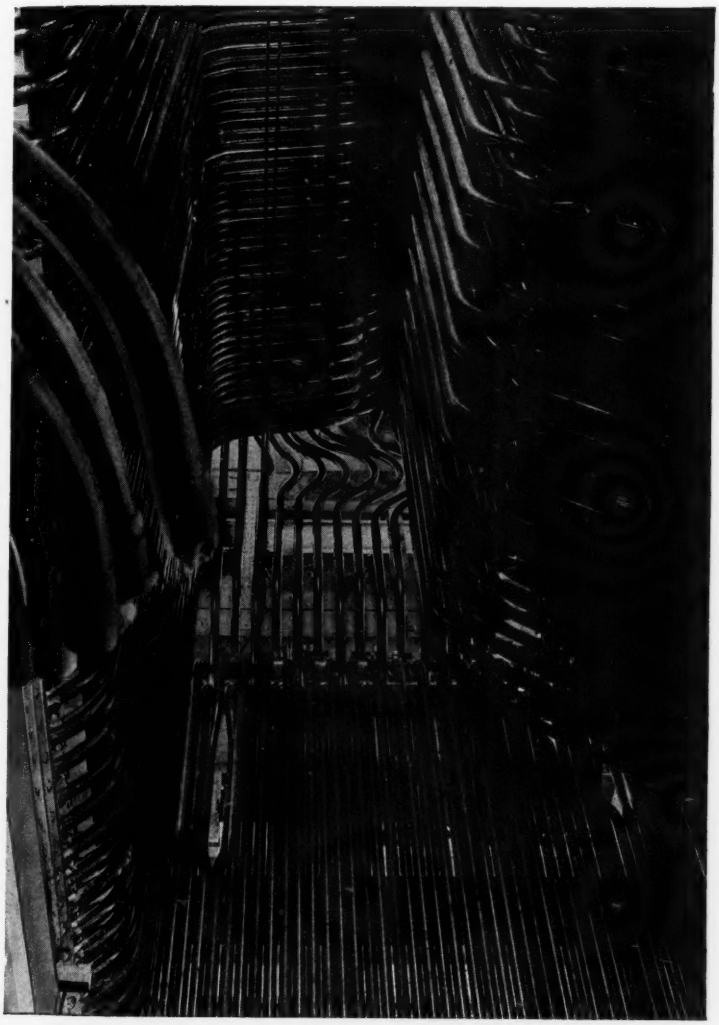
Lake Road Station



FOSTER

Cleveland

Cleveland, Ohio



OPERATING CONDITIONS

Maximum Load
350,000 lb. per hour
665 lb. per sq. in. pressure
835 deg. F. final steam temp.
350 deg. F. feedwater
87 per cent efficiency

Left: Looking up into one of the new furnaces at Cleveland; at right are slag screen tubes shielding pendant superheater.

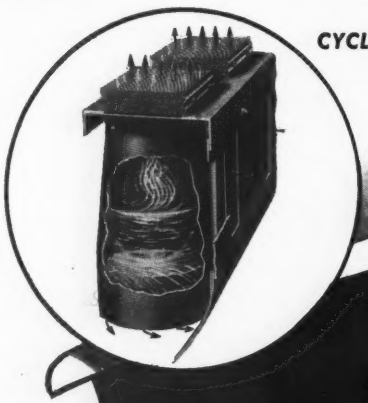
The new steam generating installation at the Lake Road Station of the City of Cleveland consists of three, three-drum units as illustrated. They are fired by ball pulverizers through intertube burners and fitted with continuous slagging furnaces, convection superheaters and tubular air preheaters. Final steam temperature is controlled by regulating flow of gases over superheater surface as indicated by dotted line in the drawing

A 25,000 square foot surface condenser, condenser tubes, axial flow circulating pumps, condensate pumps, air ejectors, evaporators, and feedwater heaters in this station are also by Foster Wheeler.

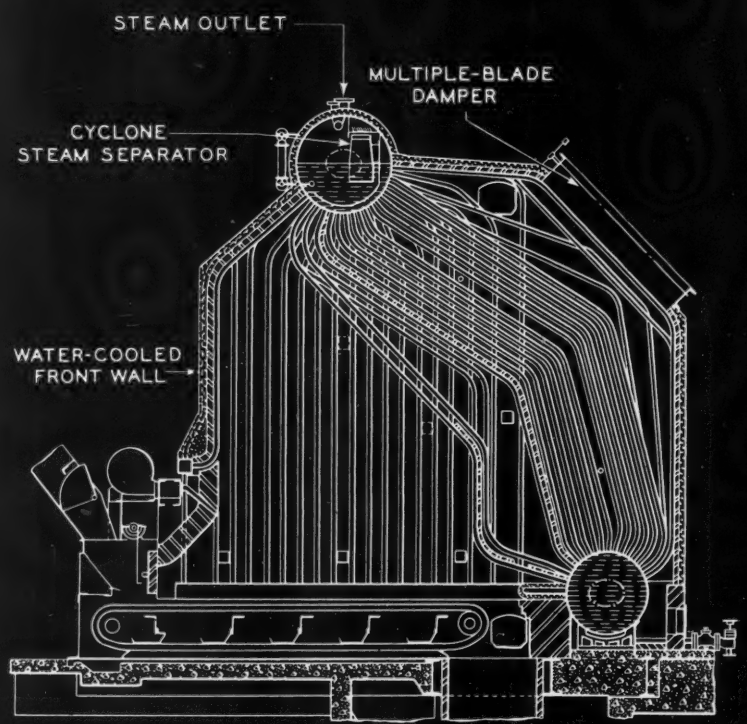
FOSTER WHEELER CORPORATION, 165 Broadway, New York

WHEELER

for SIMPLIFIED OPERATION



CYCLONE STEAM SEPARATOR



SECTIONAL ELEVATION

THE BABCOCK ... ANY

BABCOCK

in SMALLER PLANTS —

B&W INTEGRAL FURNACE BOILERS

TRADE MARK REG. U.S. PAT. OFF

CLASSES 9, 12 & 15

DRY CLEAN STEAM is obtained over a wide range of operating conditions by the use of B&W Cyclone Steam Separators, used heretofore only on larger B&W boilers where extreme purity of steam is desired.

STEADY WATER LEVEL and more nearly correct indication in the gage glass are assured by the Cyclone Steam Separators, which provide steam-free water in the drum and downtake tubes, and minimize water-level variations caused by load changes.

LESS BLOWDOWN. The high boiler-water concentrations permitted by Cyclone Steam Separators result in less blowdown than is required by conventional-type boilers in similar service. Draining and blowdown are effected through one blowdown connection.

EFFECTIVE SOOT BLOWING. The boiler tubes, arranged with straight lanes between the rows, are well adapted to cleaning by means of soot blowers. Two elements do the job effectively.

EASY INSPECTION AND CLEANING. All pressure parts are readily accessible for inspection and cleaning. All the header handholes are accessible from outside the boiler. The steam drum internal fittings are easily removed when necessary. The steel casing facilitates good housekeeping.

To these advantages add reduced costs of fuel and maintenance, and economical construction.

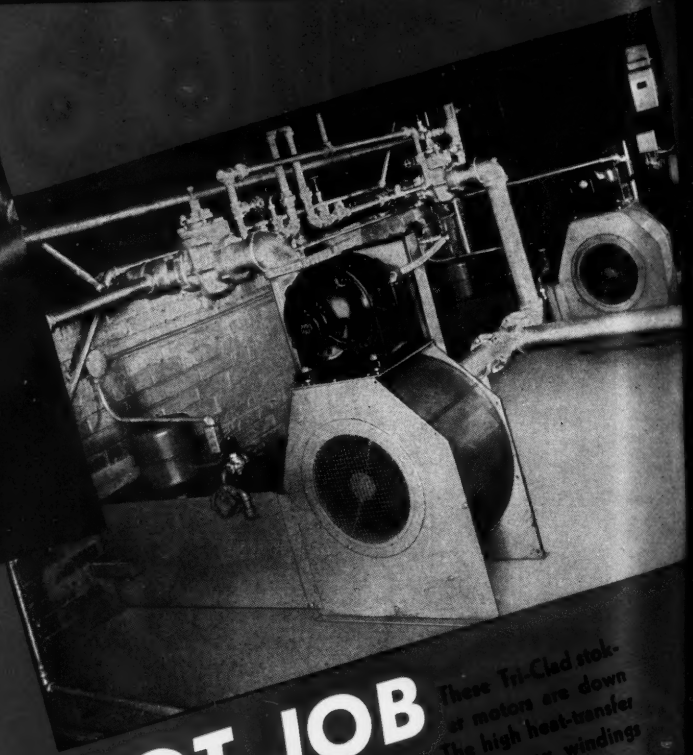
For complete information about the Babcock & Wilcox Integral-Furnace Boiler, write for Bulletin G-34A. G-219 T

85 LIBERTY STREET, NEW YORK

& WILCOX

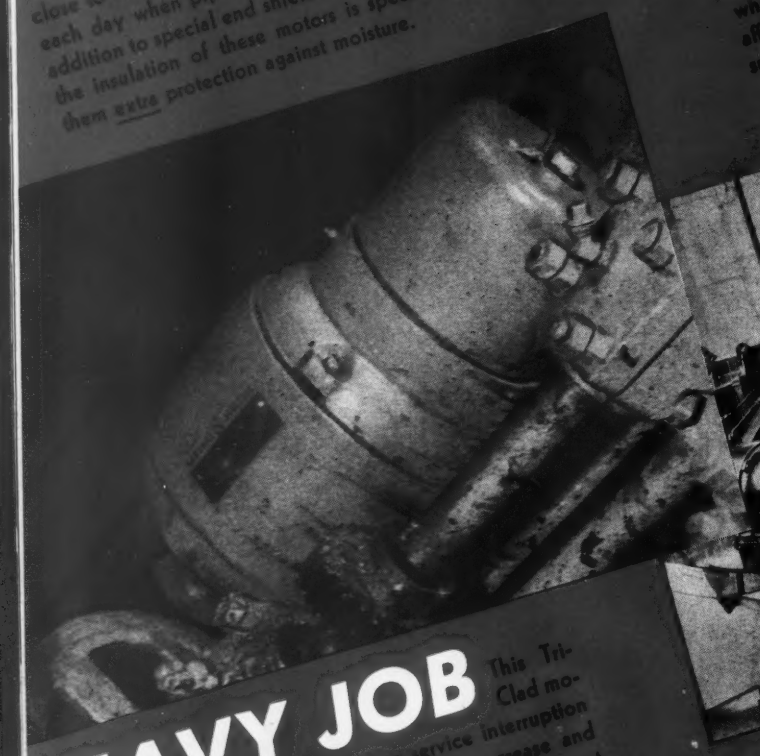
WET JOB

Here's a Tri-Clad splashproof motor close to the floor in a dairy plant. It gets its share of the wet each day when pipes and floor are cleaned and steamed. In addition to special end shields and watertight conduit boxes, the insulation of these motors is specially designed to give them extra protection against moisture.



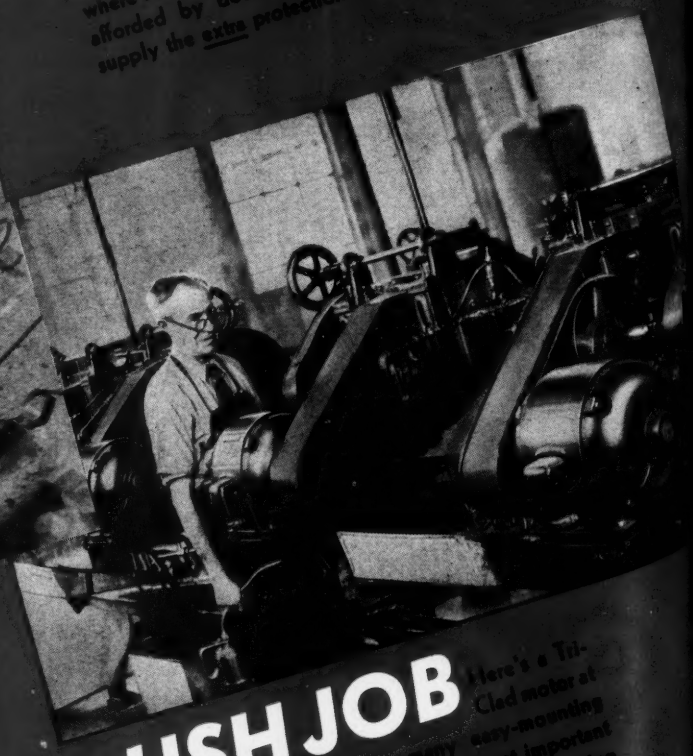
HOT JOB

These Tri-Clad stok- er motors are down where red-faced firemen used to sweat. The high heat-transfer afforded by double-end ventilation and Formex windings supply the extra protection needed for this service.



HEAVY JOB

This Tri-Clad motor is installed on a lift bridge, where a service interruption could be serious. In these surroundings, where grease and grime are to be expected, a protective frame is an important factor in continuous operation.



RUSH JOB

Here's a Tri-Clad motor at work in the arms industry. The many easy-mounting features of Tri-Clad motors can help plants get important tools into operation quickly. Their extra-protection features will help keep vital equipment in triple-shift operation.

BUILT FOR PROTECTION FIRST . . . . TO LAST!

BIG JOB On machine tools vital to America's war effort, motors are well guarded against falling metal chips or dripping coolants by their own sturdy, cast-iron frame and end shields.

DIRTY JOB [illegible] have coated this Tri-Clad ball-bearing motor. Note how dust is serve for which we do not recommend open motors, such as that shown, we are glad to chalk up this instance of motor stamina under severe operating conditions.

TODAY'S TOUGH JOBS CALL FOR TRI-CLAD MOTORS

REG. U.S. PAT. OFF.

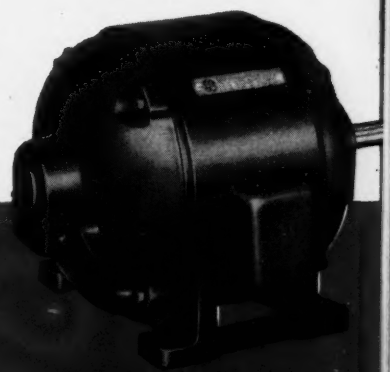
NOW more than ever, you must be sure that your motors give you 24-hour operation, even on the *toughest* jobs. Here's where Tri-Clad motors can be a real asset—their *extra protection* features* give them the stamina necessary to keep your equipment in operation in spite of adverse operating conditions.

The Tri-Clad motor's cast-iron frame and end shields are a safeguard against accidental blows—they shield the motor from falling objects and dripping liquids. The stator winding, of Formex wire, is proof against damage from oil, moisture, and heat shock. Improved bearings are easily lubricated, and are sealed against the entry of dust or dirt by complete enclosure in cast iron.

All in all, these protection features are sound assurance of an *extra tough* motor for use on equipment that can't be allowed to quit on the job. Ask your G-E representative for details on types and sizes now available, or write General Electric, Schenectady, N. Y.

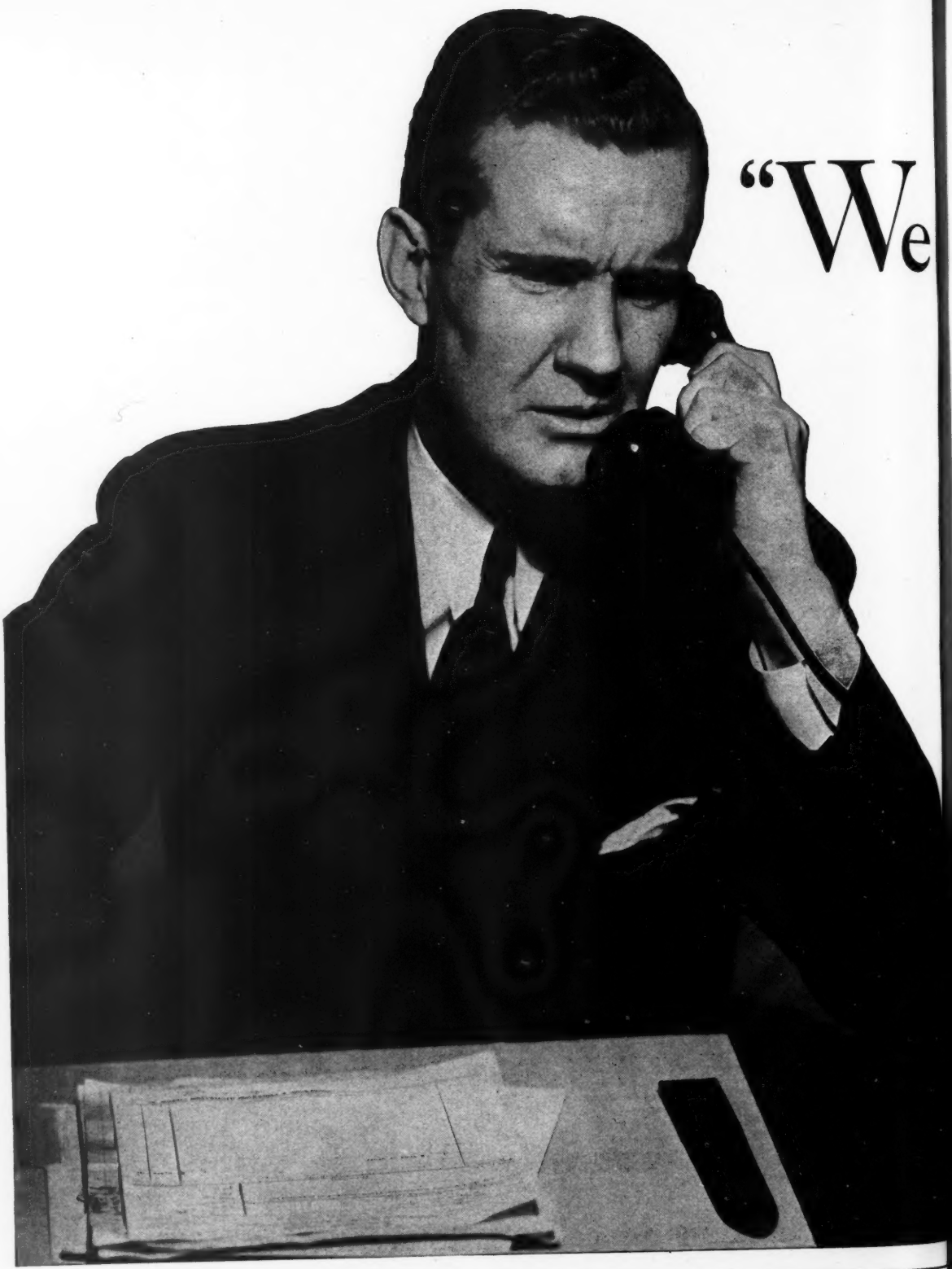
*Extra protection against physical damage, electrical breakdown, and operating wear and tear.

General Electric and its employees are proud of the Navy award of Excellence made to its Erie Works for the manufacture of naval ordnance.



GENERAL ELECTRIC

750-112-8058



HALL LABORATORIES, INC. · 300 ROSS STREET

simply can't stand any boiler outages now...

—— Holy smokes, Joe, this is a job for *experts*. Half-way measures won't do. That boiler has *got* to stay on the line 24 hours a day and *seven* days a week at *full capacity*—and, brother, I *mean* full."

You can't afford to take the slightest chance on boiler outages caused by feedline deposits, tube burn-outs, embrittlement, economizer corrosion, a burned-out superheater or scale on turbine blading.

You will need *steam* and all you can get—high-quality steam that will keep your plant roaring *safely* at "full speed ahead" 24 hours *every* day for the *duration!*

This is a job for Hall Service. Call in the Hall Engineer today. He'll help you keep that boiler humming till the boys come home—and even *then* it won't need a rest!

HALL SERVICE IN A NUTSHELL

At your immediate disposal are placed the technical knowledge and facilities of the pioneering leaders in scientific boiler water conditioning.

In addition, with your full cooperation, Hall Service:

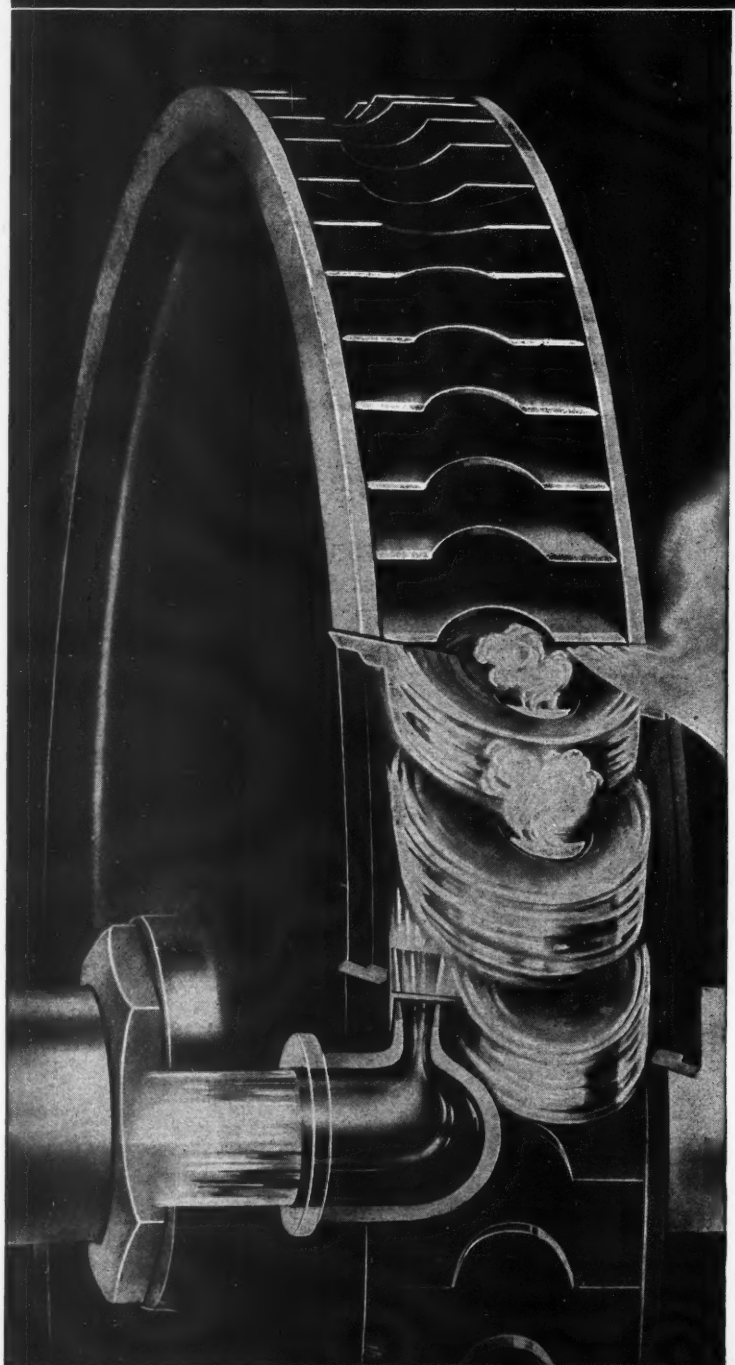
1. **Minimizes boiler outages caused by water.**
2. **Helps maintain highest efficiency.**
3. **Establishes non-embrittling water.**
4. **Minimizes carryover.**
5. **Prevents corrosion in boilers and associated equipment.**
6. **Prevents deposition in water lines and cooling systems.**

In trouble—
the "best bet" for correction

Out of trouble—
the "best yet" for protection.

HALL SYSTEM
of Boiler Water Conditioning

PITTSBURGH, PA.



RELIABILITY FIRST!

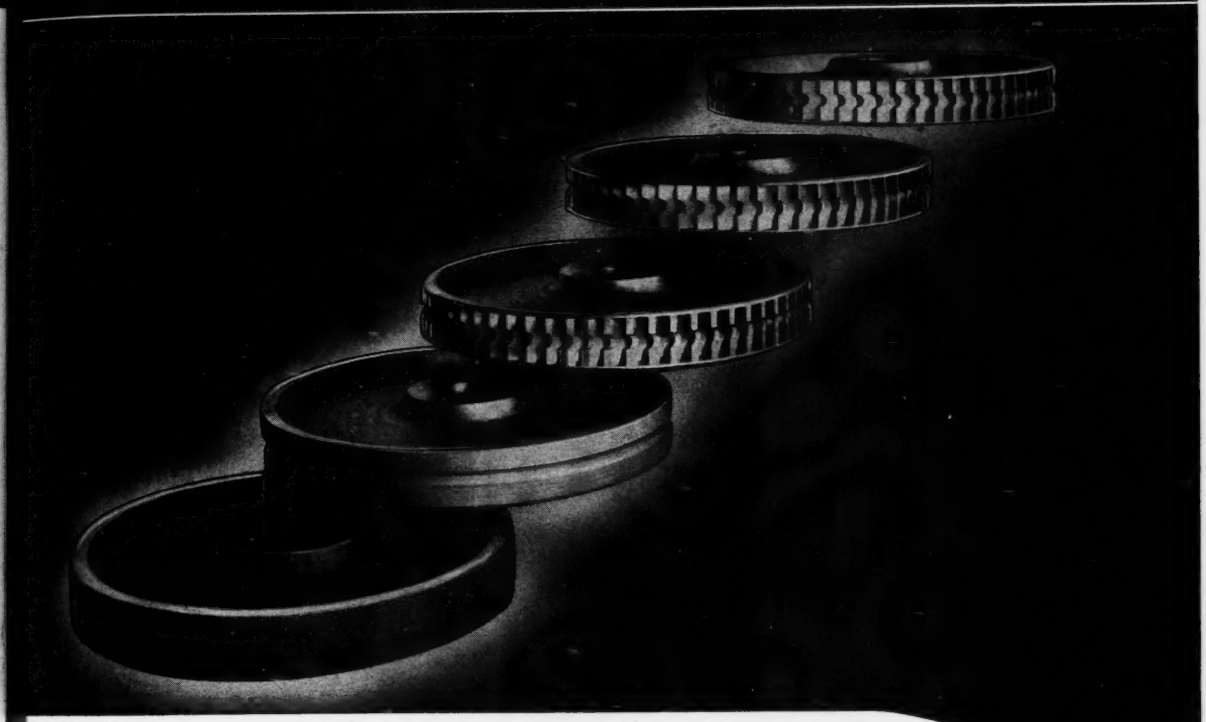
Throughout the entire forty-nine years that the Terry Turbine has been on the market it has always been the Terry policy to build first of all for reliability.

That this policy has been appreciated is proven by the very extensive use of Terry turbines where only the most trustworthy apparatus is permissable; namely in outstanding central stations, leading industrial plants and on large Naval vessels. The Terry today still maintains that preeminent position in these most exacting fields which it immediately took upon its introduction.

At Left:—

Action of steam in Terry wheel turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket in which its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.

THE TERRY STEAM TURBINE CO.



STEPS IN THE MACHINING OF A TERRY TURBINE WHEEL — From left to right:
1. Rough turned forging. 2. Smooth turned. 3. First milling cut. 4. Second milling cut. 5. Finished wheel.

TERRY WHEEL TURBINE ADVANTAGES

— The blades and the wheel are in one piece so that there are no parts to become loose or work out.

— The blades have large clearances.

— The blades are double rim protected.

— End play will not damage the blading.

— It is impossible for the blades to foul.

— The power producing action of the steam in the wheel takes place on the curved surfaces at the back of the buckets and, therefore, close blade clearance is not necessary.

— The only function of the blades is to form a series of pockets, wear of the blade edges is of little consequence and does not materially affect the horse power or efficiency. The important part of the bucket is the back or bottom which is a solid forging.

— There is practically no end thrust since the steam enters and leaves the wheel in a direction at right angles to the shaft.

ASK FOR BULLETIN S-116

T-1143

TERRY SQUARE - HARTFORD, CONN.

"little toppers" designed

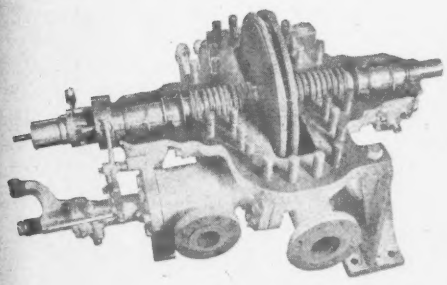
up to 1500# — 950°

and built by steam headquarters especially for

heavy-duty auxiliary drive service

The Westinghouse Type CH is *not* an overgrown light-duty turbine. It is designed and built especially for heavy-duty auxiliary drive service. In fact, it was engineered specifically to help you take full advantage of modern steam practice. And that kind of high-temperature, high-pressure service spells *heavy-duty*.

Check these design features and you'll understand why the Type CH line can take it at ratings up to 2,000 hp, for steam conditions through 1,500 lbs. gauge inlet pressure, 950° F. total temperature, and 300 lbs. gauge exhaust.



- **Exceptionally heavy steel construction throughout. Both casing flanges are finish-ground to form a steamtight joint. Extra heavy alloy bolting is used.**
- **Pressure lubricated bearings designed for low-temperature operation in heavy-duty service.**
- **Extra heavy shaft sprayed with high chrome-nickel steel at the gland zones to prevent rust-cutting of carbon rings.**
- **Carbon glands with corrosion-resistant steel gland cases (extra rings for high exhaust pressures).**
- **Streamline steam path—contoured for maximum efficiency.**
- **Shrouding secured by spun blade tenons.**
- **Dynamically balanced rotor.**
- **Powerful, sensitive speed regulating governor.**

These turbines are available in a wide selection of combinations to take full advantage of economies made possible by modern steam practice. They are well adapted to serve as stand-by drive in power plants having high-temperature, high-pressure boilers, and are often applied industrially where the existing low-pressure system is operating at capacity. Write for Bulletin B-3012 on Type CH Turbines. Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa., Dept. 7-N.

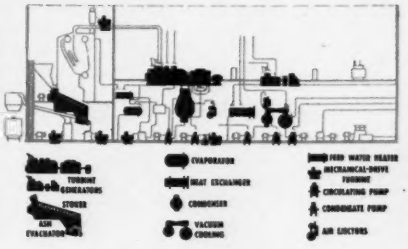
J-50400

Extra values in all these products of steam headquarters

Westinghouse

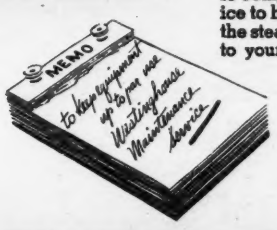
1. equipment

A *complete* range of steam turbines for mechanical or generator drive, from 5 hp to the world's largest . . . with a full line of auxiliary steam equipment.



2. engineering

A *complete* engineering service to help you select and apply the steam equipment best suited to your requirements.



ARMSTRONG "Side Inlet" STEAM TRAPS

EXPERIENCED heating and piping men and plant operating engineers are quick in recognizing the superiority of the design of Armstrong 800 Series traps with "straight-thru" pipe connections. The pipes are connected to the body, NOT TO THE CAP, thus, when you loosen the cap bolts, you have the "whole works" ready to lift out for convenient, easy inspection on your work bench. The body itself stays in the line—no messing with a body full of hot water, no nuisance of breaking and remaking pipe connections.

This is the design that Armstrong pioneered more than 10 years ago. Due to the long wearing qualities of Armstrong traps, most users don't have much occasion to notice these "convenience" features, nevertheless, they're there—ANOTHER ONE OF THE "PLUS VALUES" USERS GET IN ARMSTRONG TRAPS!

For catalog, write Armstrong Machine Works, 810 Maple St., Three Rivers, Michigan.

The Cap Carries the "Whole Works"

ARMSTRONG INVERTED BUCKET STEAM TRAP

ARMSTRONG MACHINE WORKS

Purring like a kitten today—
BUT RUST MAY STRIKE TOMORROW!
Right now rust can be working on the delicate governor mechanisms of your turbines . . . then without warning—trouble! To help prevent costly shut-downs and overhauls change over your turbines to *new* Shell Turbo Oil—it can prevent rust! The first turbine oil to meet all 3 vital requirements of modern turbine lubrication, it offers
RUST PREVENTION
SUPERIOR OXIDATION STABILITY
MINIMUM FOAMING TENDENCY
Why accept less? Call in Shell today!
Keep YOUR turbines humming with
SHELL TURBO OIL
SHELL

All 8 Resist Corrosion and provide lasting STRENGTH...

plus **CORROSION RESISTANCE** . . . together, with strength, hardness, toughness — **MONEL**

plus **EXTRA HARDNESS** . . . comparable to heat-treated alloy steel; heat-treatable, non-magnetic — **"K" MONEL**

plus **HEAT RESISTANCE** . . . with retention of high degree of strength. Resists oxidation, high corrosion resistance — **INCONEL**

plus **MACHINABILITY and EXTRA HARDNESS** . . . free cutting, heat-treatable, non-magnetic — **"KR" MONEL**

plus **RESILIENCE** . . . heat-treatable, for exceptional spring properties, magnetic, good electrical conductivity — **"Z" NICKEL**

plus **MACHINABILITY** . . . for high speed production in automatic screw machines — **"R" MONEL**

plus **HARDNESS in CASTINGS** . . . anti-seizing and non-galling — **"S" MONEL**

plus **NON-CONTAMINATION** . . . protects product purity; offers good electrical conductivity — **NICKEL**

Offering unusual combinations of properties, INCO Nickel Alloys render valuable service in peace or war

Now, more than ever before, vital parts of equipment must *stand up in service.* Where such parts are subjected to stress, corrosion and wear it will pay to consider INCO Nickel Alloys.

Along with strength and resistance to corrosion, INCO Nickel Alloys combine varying degrees of resilience, heat resistance, extra hardness, non-magnetism and other useful properties.

Which of these metals to use for best results depends on the job to be done. Let INCO's technical division help you make the proper selection. Send us full particulars, or write for the new booklet, "*Individualized* INCO Nickel Alloys." Address:

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York, N. Y.

★ FIRST THINGS FIRST ★

With the Nation at war, supplies of Monel, Nickel and Nickel Alloys are needed for our armed forces. All efforts must now be aimed toward victory. In the meantime, The International Nickel Company will continue to issue information which it is believed will be of interest to metal users who are concerned with the war needs of today and the peace-time progress of the future.

SOME TYPICAL MECHANICAL PROPERTIES

INCO ALLOY	*CONDITION*	*Tensile Strength 1000 psi.*	*Yield Strength 0.2% Offset 1000 psi.*	*Elongation in 2 in. per cent*	*Hardness Brinell 3000 kg.*	*Toughness Standard Izod-ft.-lbs.*
MONEL	Cold-drawn, as drawn	85-125	60-120	35-15	160-250	115-75
"K" MONEL	Cold-drawn, heat-treated	140-170	100-130	30-15	260-320	26*
INCONEL	Cold-drawn, as drawn	95-150	70-125	30-15	180-290	100-70
"KR" MONEL	Cold-drawn, heat-treated	140-170	100-130	30-15	260-320	..
"Z" NICKEL	Cold-drawn, heat-treated	160-190	120-150	20-7	300-380	25
"R" MONEL	Cold-drawn, as drawn	80-115	50-100	35-15	150-230	99
"S" MONEL	Castings as cast	110-145	80-115	4-1	275-350	9-3
NICKEL	Cold-drawn, as drawn	65-115	40-90	35-15	125-230	120

**Specimen completely fractured.*

INCO NICKEL ALLOYS ARE YOUR ALLIES

MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • NICKEL • "Z" NICKEL

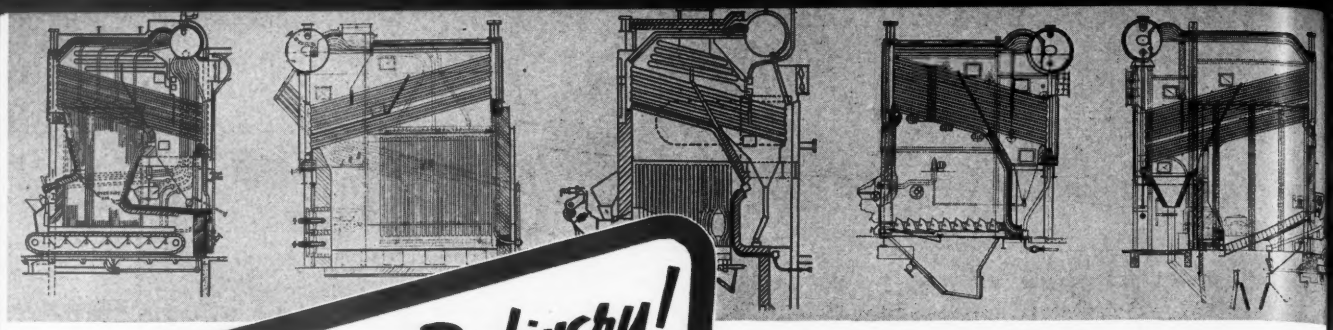
Sheet . . . Strip . . . Rod . . . Tubing . . . Wire . . . Castings

MIDWEST PIPING SERVICE IS NATION-WIDE

Now . . . that Time is more vital than ever before . . . the strategic locations of the Midwest plants for the fabrication of piping take on added importance. Each Midwest plant is a complete unit . . . provided with the most modern equipment and manned by a highly skilled organization for prefabricating all kinds of power plant and process piping. You will find it definitely advantageous to get in touch with the nearest Midwest office whenever you need fabricated piping . . . whether only a simple pipe bend, a coil or a complete alloy piping job.

MIDWEST PIPING & SUPPLY COMPANY, Inc.

Main Office: 1450 So. Second St., St. Louis, Mo. • Plants: St. Louis, Passaic (N. J.) and Los Angeles
Sales Offices: Chicago—949 Marquette Bldg. • Houston—229 Shell Bldg. • Los Angeles—520 Anderson St. • New York—(Eastern Division) 30 Church St. • San Francisco—436 Call Bldg. • Tulsa—533 Mayo Bldg.



Get Earlier Delivery! Cut Costs! Conserve Metals!

WITH A SPRINGFIELD "Duplicate" Unit

ORGANIZATIONS engaged in defense projects, or otherwise able to obtain priority ratings, can get quicker delivery . . . save money . . . and aid in conserving metals on steam plant requirements by taking advantage of the distinctive construction features of Springfield straight tube, cross drum, sectional header boilers.

DUPLICATE UNITS. Complete drawings, patterns, shop fixtures, etc., are on hand to duplicate any of the many modern Springfield steam generating units built in recent years. Capacities from 5000 lbs. to 450,000 lbs. per hour, or more. Pressures from 75 lbs. to 750 lbs., or higher.

SINGLE DRUM. A minimum amount of steel plate is diverted from shipbuilding and other urgent uses when the Springfield design is used.

SECTIONAL CONSTRUCTION. Sections of 3" tubes rolled into rugged electric cast steel headers are assembled complete with baffles in our shop saving weeks or months in field construction time, depending on the size of the units. Water walls are also shop assembled where field conditions permit.

STRAIGHT TUBES. With one size of straight tube, Springfield averages about 1/16 fewer tube sizes than common bent tube boilers which means less delay in securing materials.

RADIANT HEAT FURNACES. Springfield pioneered water walls in America. Heavy duty designs are now available for general industrial service that permit safe operation at higher ratings—more steam per pound of metal! These water walls are also being applied to existing boiler installations as a means of greatly increasing capacity at minimum cost.

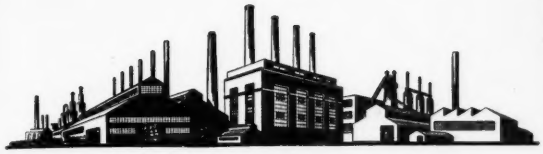
COMPLETE UNITS. Springfield regularly takes contracts for complete steam generating units. Write, phone, or wire for quotations. SPRINGFIELD BOILER CO., 1951 E. Capitol Ave., Springfield, Ill.

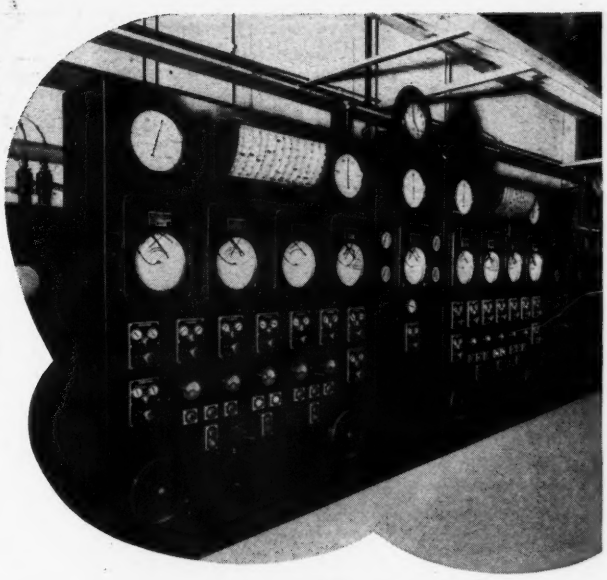
SPRINGFIELD

STEAM GENERATING UNITS

SPRINGFIELD BOILERS

ANY SIZE ANY FUEL ANY PRESSURE





This Bailey Boiler Control Panel serves multi-fuel fired boilers in a Steel Mill.

WAR STRATEGY *for* POWER ENGINEERS

1. Make Full Boiler Capacity Available
2. Conserve Fuel and Man Power
3. Prepare to Train New Operating Crews
4. Take Steps to Insure Continuity of Service
5. Protect Men and Equipment Against Accidents

★ Our fighting forces will win the war if our productive forces do not lose it by delivering" too little and too late." Every Power Engineer should map his war strategy now. We offer the following suggestions;

1. Make Full Boiler Capacity Available—by cleaning and repairing boilers and furnaces, by providing sufficient natural or mechanical draft, by continuously maintaining excess air at the minimum economical value, by careful fuel selection, and by basing both manual and automatic operation on accurate measurements.

2. Conserve Fuel and Man Power—by use of a coordinated boiler control for combustion, feed water, superheated steam temperature, heater and storage tank levels. The combustion control system should automatically make any readjustments necessary to maintain maximum fuel economy.

3. Prepare to Train New Operating Crews—by writing a clearly worded schedule of operator's duties, by reducing operation to its simplest form through the use of meters and control.

4. Take Steps to Insure Continuity of Service—by setting up a schedule for routine inspection of power equipment, by improving and coordinating operation to avoid unnecessary strain on any of the units in the system. Complete combustion control and properly applied feedwater control systems are of great aid in maintaining uniform safe operation.

5. Protect Men and Equipment Against Accidents—by the addition of interlocks and alarms to the boiler control system. Serious accidents resulting from fan failure, flame failure, high or low water levels, and other unusual conditions may be avoided by these devices.

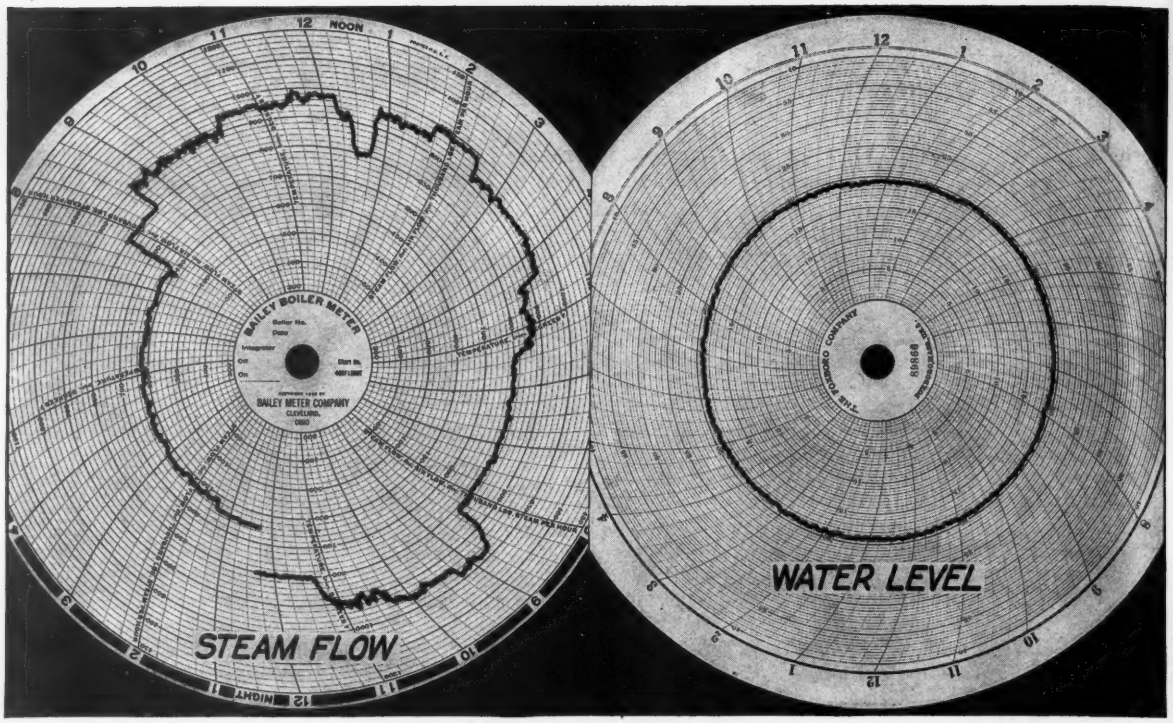
It is hoped that the foregoing suggestions may give you some help in formulating a war strategy which will help to keep your plant out of the "too little and too late" group. We shall be glad to make specific recommendations on how to include metering and control equipment in your war strategy. A-82

BAILEY METER COMPANY
1040 IVANHOE ROAD • CLEVELAND, OHIO
Bailey Meter Company Limited, Montreal, Canada

BAILEY METER CONTROL

The Complete Combustion Control System

BOILER METERS • MULTI-POINTER GAGES • FLUID METERS • RECORDERS • SUPERHEAT CONTROL • DESUPERHEAT CONTROL • COMBUSTION CONTROL • FEED WATER CONTROL



These charts show why 6 plants in this utility system use Flowmatic

This utility system first installed COPES Flowmatic in 1937. Now six of its plants are using this simplified two-element steam-flow type feed water regulator on 875-pound pressure boilers. Seven repeat orders have been placed. The charts show why.

This Foster Wheeler 3-drum boiler normally evaporates 330,000 pounds per hour, with maximum load of 400,000 pounds. Fired with powdered coal, total temperature is 860 degrees F. The motor-driven centrifugal pump has no automatic pressure control, yet the water level is held within less than plus or minus one inch by the COPES Flowmatic.

Want to know how this new COPES operates—where it is used—what results others are getting in regular service? Then write for Bulletin 429. It's worth your study!

NORTHERN EQUIPMENT COMPANY
322 GROVE DRIVE, ERIE, PA.

Feed Water Regulators, Pump Governors, Differential Valves, Liquid Level Controls, Reducing Valves and Desuperheaters

★ GET CLOSER LEVEL CONTROL WITH THE COPES FLOWMATIC ★ REGULATOR
FEEDS BOILER ACCORDING TO STEAM-FLOW-AUTOMATICALLY

5 YEARS OLD... BUT THE OIL IS STILL

LIKE NEW

● PERHAPS you have a turbine oil that's five to ten years old. But how much has it cost in treating and sweetening to keep acidity low? How much of the original oil has been lost through sludge removal? How much time have your operators spent cleaning the turbine oil system, settling tanks, and other equipment you need to get a few years' extra life from the oil?

Add these costs together and you have part of the saving you make when you install Nonpareil Turbine Oil, because it never needs sweetening or treating, and stays in the turbine year after year without becoming more acidic or forming sludge.

A 2,000 KW turbine in the Michigan municipal plant (pictured here) has operated on Nonpareil 5 years. A recent inspection shows the oil to have the extremely low neutralization number of 0.05 mgKOH/gm. This oil is *guaranteed* to last as long as the turbine.

Have a Standard Oil Engineer explain fully what this *guarantee* means to you. Write the Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago, Illinois, for the Engineer nearest you. In Nebraska, write Standard Oil Company of Nebraska at Omaha.

Copr. 1942, Standard Oil Company (Indiana)

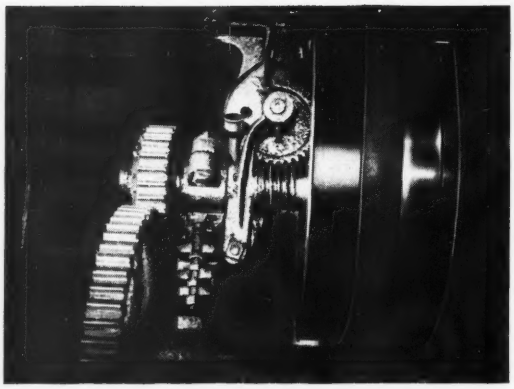
NONPAREIL TURBINE OIL

1. Stability Against Oxidation and Sludge.
2. Non-Corrosive. 3. Good Demulsibility.
4. Proper Viscosity Grades.

STANDARD OIL COMPANY (INDIANA)

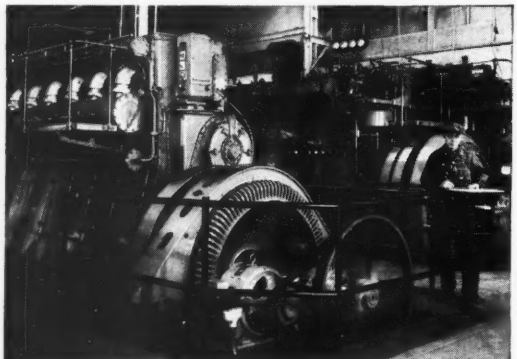
LUBRICATION ENGINEERING • • LUBRICATION ENGINEERING • • LUBRICATION ENGINEERING • • LUBRICATION E

LUBRICATION ENGINEERING...LUBRICATION ENGINEERING...LUBRICATION ENGINEERING...LUBRICATION



NO TIME TO REPLACE DRIPPING BEARINGS? TRY— STANODRIP

Have you been putting up with dripping line shaft and equipment bearings because there isn't time to replace them and because they are hard to get? You can still get rid of the oil-soaked floors under these bearings and save the time and lubricant they waste. Do as one Michigan laundry superintendent did when he found that he had to lubricate machine bearings often and mop oily floors—and, worst of all, that oil was thrown on the clean laundry from time to time. He took a Standard Lubrication Engineer's advice and tested Stanodrip. A three-month trial showed consumption was reduced 75%—Stanodrip stayed *in* the bearings, *off* the floor and laundry.



"THE ONLY OIL CONSIDERED" AFTER 10-YEAR RECORD WAS NONPAREIL DIESEL OIL

It was time to choose the lubricating oil for the new Diesel shown in the foreground of the above picture. The second engine had operated 10 years on Nonpareil Diesel Oil. Operator Oliver Lindahl at this Missouri municipal plant looked at its record. No stuck rings in 10 years. No sludge or excessive carbon. Low maintenance and oil consumption. No engine could have given less trouble. And, with that evidence, no other oil was considered. Nonpareil got the job. Ask a Standard Oil Engineer to recommend the grade you need and test it. Let your records show how economical Diesel operation can be.

SUPERLA GREASE APPROVED FOR MILL BEARING LUBRICATION

Alvin Enerson, pictured above, is giving you the benefit of a lot of experience, when he says, "Your Superla Grease has been in use in our pellet mill for several months. It has given the results we have been looking for. Not a single bearing failure has occurred in this period."

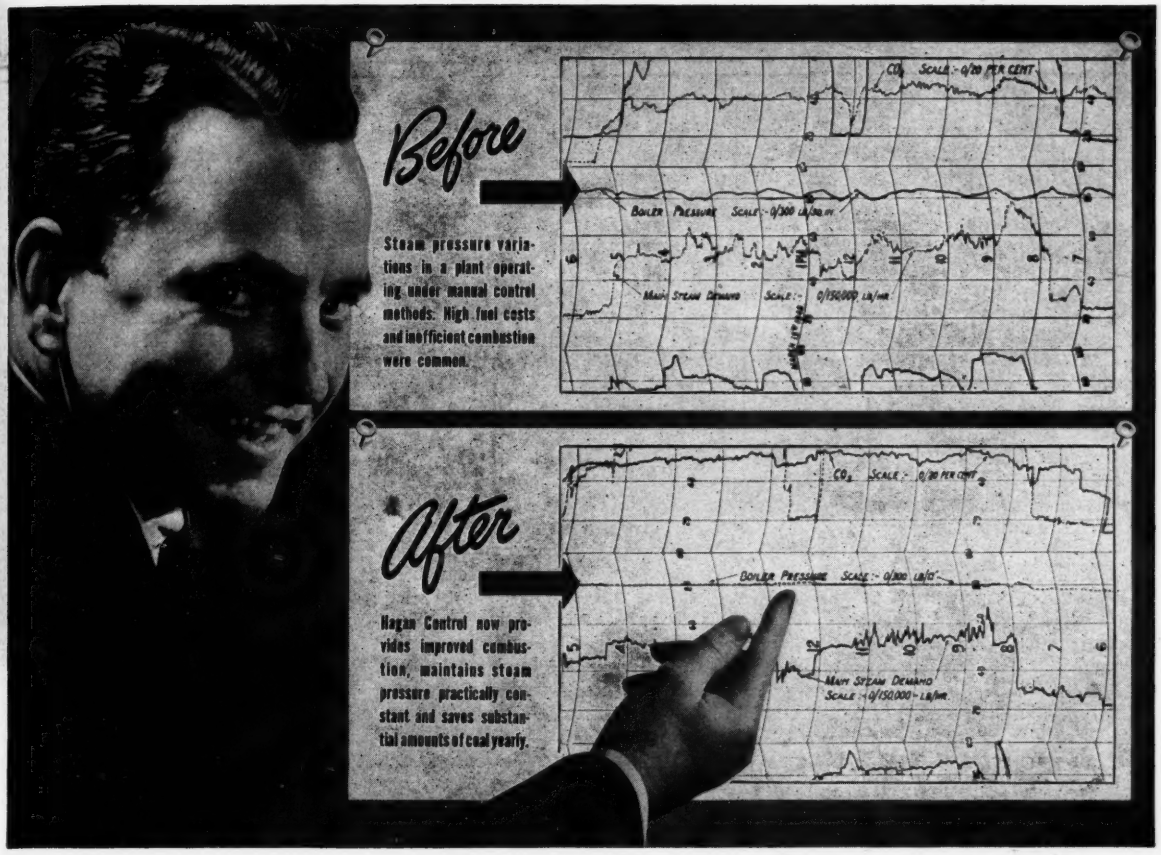
He had tried many greases on this mill in the plant of the Stockdale Fertilizer Co., Morrison, Illinois. But none of them would stand up. Leakage, high grease consumption, and bearing trouble persisted.

When a Standard Lubrication Engineer first suggested testing Superla, it was just another faint hope of help that prompted Mr. Enerson to try it. But there is no doubt in his mind now. Superla not only ended bearing trouble, but it cut consumption 40%, and saved hours of machine productive time.

LUBRICATION ENGINEERING WILL HELP YOU SAVE TIME AND MAINTENANCE

Right now, when your time is at a premium, you should meet the Standard Lubrication Engineer in your locality. His suggestions may save a lot of your time experimenting with lubricants. The sooner your lubricating problems are solved, the more you save in maintenance expense and lost machine time. Just write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago, Illinois, for the Engineer nearest you. In Nebraska, write Standard Oil Company of Nebraska at Omaha.

Steam pressure down? Blood pressure up?


Before
Steam pressure variations in a plant operating under manual control methods. High fuel costs and inefficient combustion were common.
After
Hagan Control now provides improved combustion, maintains steam pressure practically constant and saves substantial amounts of coal yearly.

Now more than ever before you need Hagan Combustion Control

LOTS of *blood* pressures, in addition to *steam* pressures, are going for a buggy ride in the hard days ahead *unless* steps are taken *now* to keep present equipment in use at *maximum* efficiency *without* interruption.

One way to get highest efficiency from existing boiler equipment is to install *fully automatic* Hagan Combustion Control. It steps up plant efficiencies to new high levels and keeps steam pressures steady under heaviest load demands. In most cases, too, the improved combustion you get with Hagan Control effects a neat saving in fuel costs.

Here are three more good reasons for installing Hagan Control immediately:

1. Facing skilled-labor shortages because of the war, Hagan Control will maintain your plant efficiency while you break in new men.

2. In case of air raids, which right now are not impossible, Hagan Control will carry on alone until the "all clear" signals your men back to work.

3. If power demands drop suddenly during a black-out, Hagan Control will make the necessary adjustments *automatically* to hold the steam pressure constant.

The time to do it is *now, before* steam pressure losses and plant shutdowns give your blood pressure a high-altitude test. Our engineering staff is at your service. Call or write for complete engineering information without delay.

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HAGAN *Automatic* COMBUSTION CONTROL

The pioneer . . . and still the leader

Deposit Attack

Local Corrosion Caused by Foreign Matter

It is sound economy, even in normal conditions, to get all possible life from condenser and heat exchanger tubes, but it is particularly important now that uninterrupted power production is so very vital and copper base alloys on the material list to be conserved wherever possible.

Dezincification can be eliminated as a cause of tube failure by the use of Phosphorized Admiralty tubes.

Special alloys are available to resist acidity, high temperature and corrosion caused by velocity.

Corrosion of "deposit-attack" type can be best controlled by close attention to operating conditions.

In many cases, condenser tube life is very seriously impaired by deposits of foreign material which are carried into the tubes by the circulating water and become lodged against the tube wall. An intense local corrosion is frequently observed at points of contact between the tube surface and such foreign matter as stones, shells or other marine growth, cinders, scale, etc. An accelerated corrosion of this type, commonly known as "deposit attack" may reduce the life of condenser tubes from several years to a few months.

Corrosion of tubes from "deposit attack" may result simply in very extensive pitting beneath the deposit — due to a difference in potential between such shielded areas and adjacent areas richer in oxygen. Very often, however, a partial obstruction of the tube by foreign material results in increased velocity of the water, accompanied by turbulence and separation of air at low pressure areas just beyond the obstruction, and leads to severe erosion of the tube wall for some distance from the deposit.

The illustrations on the facing page clearly show what happens to condenser tubes in service when "deposit attack" proceeds at and in the vicinity of an obstruction in the tube.

The top photograph was taken of a condenser tube which failed in service. When this tube was sectioned lengthwise and opened up so that the inside surface of both halves of the tube could be inspected (Figure 1), one section ("A" in the illustration) showed a stone very tightly wedged in the tube and directly opposite this obstruction, the other half of the tube ("B" in the illustration) showed a very tiny perforation of the tube wall (seen in the illustration as a very small white spot). At and in the vicinity of the obstruction (particularly on the down stream side), interruption of the straight line flow of the circulating water with resulting turbulence brought about very severe erosion of the tube wall (seen in the photograph by the roughened irregular areas along the tube length). This is a rather unusual specimen in that the deposit was found intact in the tube after the tube was removed from the condenser; in most cases of this kind, the foreign material is gradually dislodged as corrosion proceeds, and is carried away by the circulating water or loosened and lost during removal of tube from the condenser.

The two halves of a tube, pictured in Figure 2, show an intensely corroded area near the inlet end of the tube. Perforation of the tube wall has occurred at two locations (elongated white areas in the photograph).

This failure is an excellent example of "deposit attack" and its very intense action on the tube. As indicated in the photograph, corrosion of this tube was limited to a relatively small area in the vicinity of the deposit or obstruction while the remainder of the tube surface was not appreciably corroded. This tube actually served less than six months before failure because of a deposit, yet its normal life would have been several years.

Another excellent example of a condenser tube failure resulting from "deposit attack" is shown in Figure 3. This illustration was made of the half section of a condenser tube which included the point of failure; the perforation of the tube wall is identified as a small circular white spot at the intensely corroded area. This failure is very similar to the one illustrated in Figure 2. It is relatively easy to identify the type of tube failure resulting primarily from "deposit attack." It is not so easy to trace the source of such trouble and to take precautionary measures against further damage to tubes from this cause. Attention to certain contributory factors, however is often profitable in preventing or minimizing tube corrosion of the "deposit-attack" type with resultant improved condenser tube life and a corresponding freedom from condenser shut-downs, tube replacements and maintenance expenses.

If your condenser tube corrosion problem can be traced to deposits of foreign material in tubes, the following suggestions are offered for minimizing trouble from this source: —

1. Adequate screening of the circulating water before its entrance into the condenser to make reasonably certain that no foreign material, such as shells, cinders, stones,

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one product . .
SERVICE IN MANUALS.

etc., can pass through or around the screens.

2. A survey of water channels, intake canals, the source of the water supply (such as river, reservoir, bay water, etc.) for any evidence of a filling-in with silt, vegetation, marine growths or other material which would gradually be carried into the condenser and condenser tubes. A cleaning or dredging may be required periodically to eliminate this possible source of trouble.

3. A periodic careful cleaning of condenser tubes, particularly until the source of the trouble is located and corrected. Cleaning should be as often as necessary and as thorough as possible taking care to prevent scoring or otherwise damaging the tube walls.

Individual Study Required

Condenser tube corrosion is an individual problem and most applications require special study. We shall be glad to work with you on any condenser or heat exchanger tube problems you may be facing.

Thus Scovill's service in *men* is combined with its service in *metals* — to bring to the scene of your problem the appropriate results of our engineering research.

A third Scovill service is *manuals*. If we know what your operating conditions are, we can send you literature which will be helpful. Write Scovill Manufacturing Company, 17 Mill Street, Waterbury, Connecticut.

Scovill, for many years a regular source of supply for the U.S. Government, is cooperating in every way to forward defense plans. When deliveries are not as prompt as our customers desire, we hope they will realize that delays are sometimes unavoidable and part of the price paid for national defense.

Fig. 1-A

Fig. 1-B

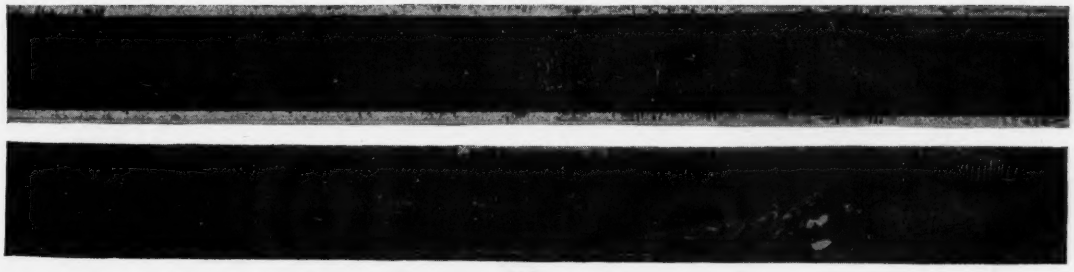

Fig. 2

Fig. 3

Condenser Tubes

. . . three services

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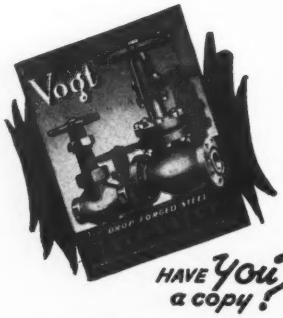

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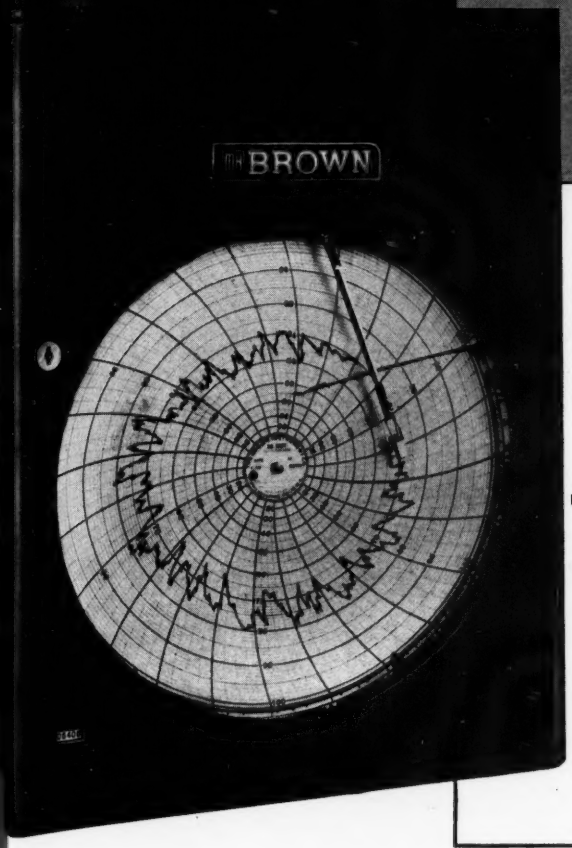

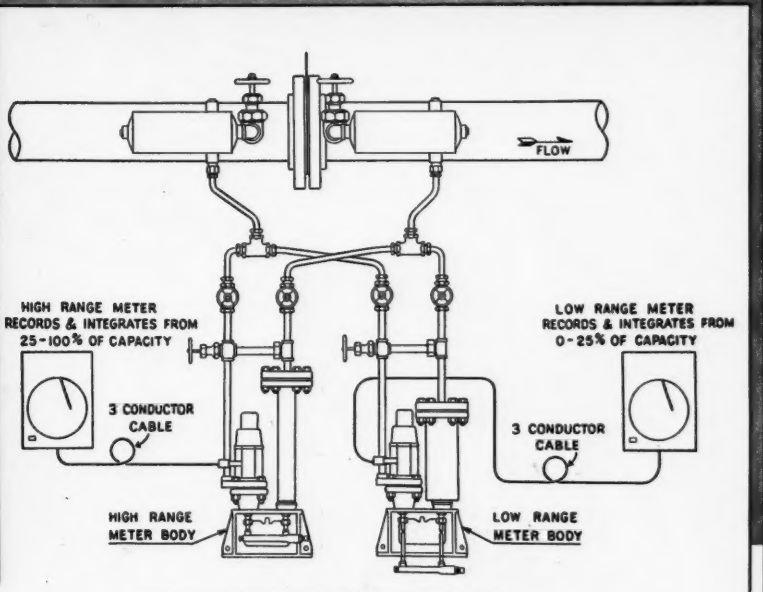
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Either or both meters can be supplied with auxiliary indicating scales and can be equipped with air control features in case it is desired to limit the maximum flow.

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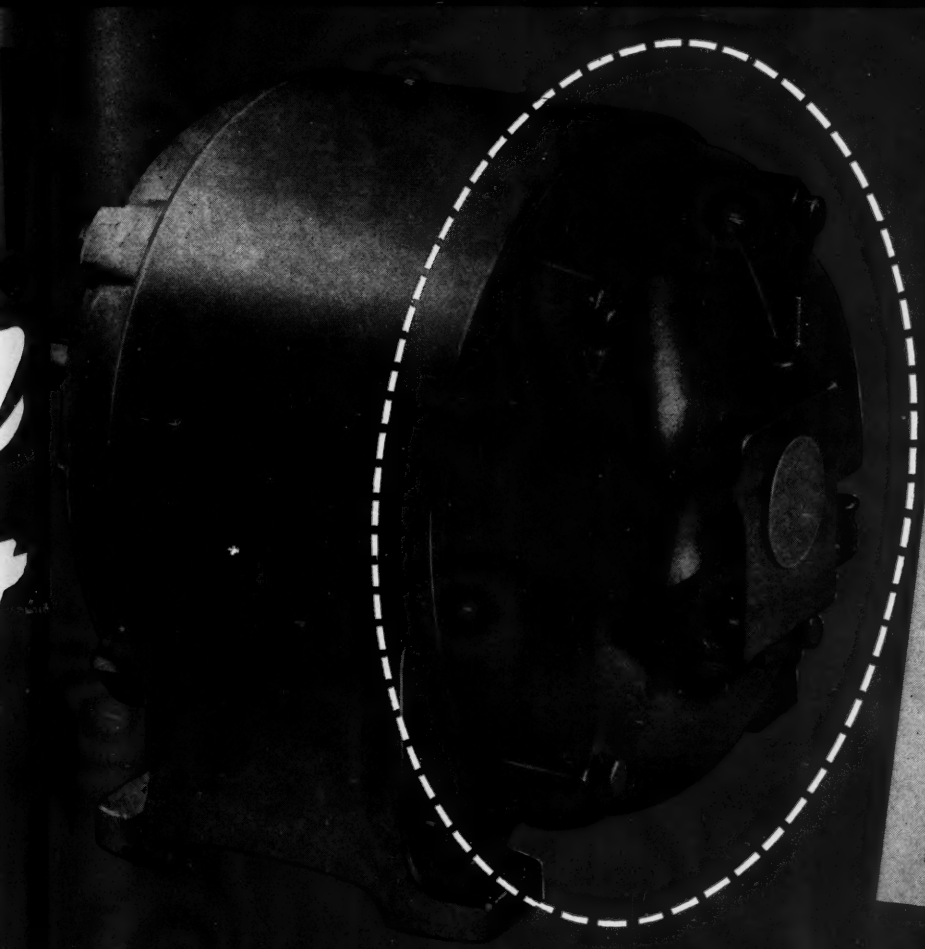

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cast as part of the frame — which forms an unbroken circle of protection around the stator. One-piece cast frame and cast end-brackets guard against exterior knocks and abuse.

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Shorter, stronger bearing design delivers smooth performance with full-flow lubrication and easier maintenance. New machining and production methods make all parts uniform and interchangeable.

Other Lo-Maintenance features of this outstanding NEW Motor are oil drains at the bottom of the bearing box for easy flushing, removable end-brackets and large conduit box for handy wiring.

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*Don't confuse this NEW motor with higher-priced motors for so-called special purposes. All the extra advantages of this standard motor are yours *at no extra cost!* A 1484

MOTOR WITH "Safety Circle" PROTECTION

IRON FIREMAN P·S· STOKER Tops the

(PNEUMATIC SPREADER)

P·S· Superiority is Demonstrated by this Typical Installation

Evaporation per Pound of Coal Increased 16%* in South Carolina Plant

(By Jack Fanning, Condensed from "Southern Power and Industry")

AN interesting boiler reconditioning job, resulting in annual savings of $11,800, was completed in 1940 in the steam plant of the Hartsville Print & Dye Works, located at Hartsville, S.C. The plant has been in operation long enough to allow cost comparisons.

It was found necessary, due to additional steam operated equipment being installed in the factory, to increase steam capacity. A survey was made at that time, including evaporation tests to determine steam capacity and requirements. From the result of these tests, recommendations were submitted to equip the 525 h.p. Babcock & Wilcox boiler for pneumatic spreader stoker firing.

JACK WEST
Master Mechanic, Hartsville Print & Dye Works.

The installation proved satisfactory from both an operating and an efficiency standpoint. The plant now shows an average over-all efficiency of 76.5% with the boiler operating at an average of 162% rating, including two or three hour peaks of operation at from 200% to 225% rating. (Former over-all efficiency was 66%.)

The equipment has proved that it is capable of burning any of the coal available in the area, regardless of ash content or fusion point of ash.

Since the boiler was reconditioned and placed in operation last September, the fuel cost per thousand pounds of steam has been reduced 21½%. *Studies show that the total investment involved is liquidated in 12 months' time.**

Tests before and after improvements to the 525 h.p. boiler indicate that the old performance gave only 9½ lb. evaporation per lb. of coal; whereas, now the evaporation is raised to 11.09 lbs. of water per lb. of coal—an increase of 16%.

**This represents an earning on the investment in Iron Fireman P. S. Stokers of 100% a year.*

IRON FIREMAN

THE IRON FIREMAN

Automatic Coal Stokers

...hfield these 5 Ways:

No other stoker in the world brings you all these advantages of the Iron Fireman Pneumatic Spreader.

1 **Fuel Economy.** Burns efficiently such economical fuels as the lower grade bituminous coals and also sub-bituminous and lignite coals. Coal is conveyed and distributed on a stream of air or hot gases. The fines burn in suspension, utilizing the conveying air for combustion. The larger pieces form a shallow fuel bed on the grate.

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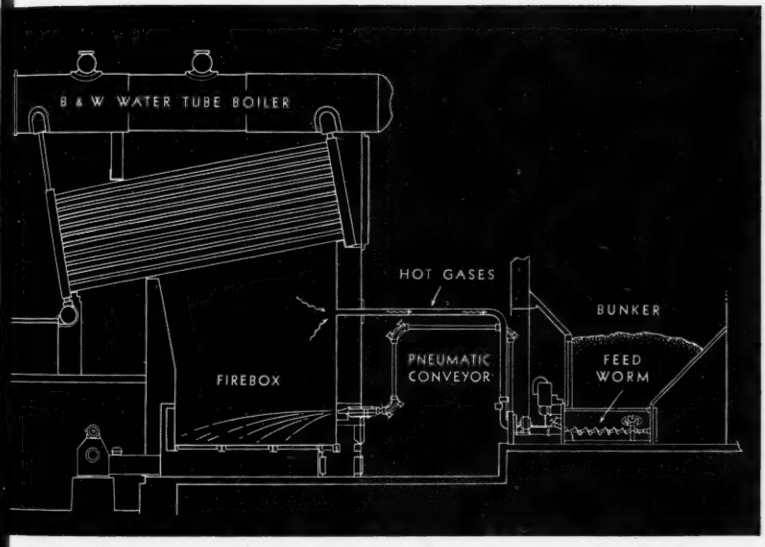
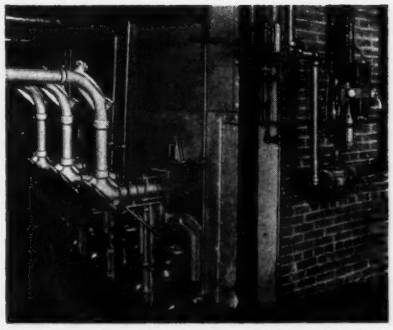
3 **Ease of Operation.** Coal is automatically fed either from a large-capacity hopper or directly from the bunker.

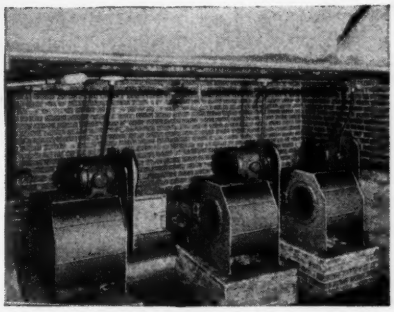
4 **Low Maintenance.** No moving parts are exposed to fire-zone. Grate design provides ample coaling. Lubrication system is positive and efficient. Users' records show very low costs per ton of coal fired.

5 **Reliability.** The Pneumatic Spreader stoker was pioneered and developed by Iron Fireman, the world's largest builder of automatic coal firing equipment. It is ruggedly built, of the finest materials, to precision standards.





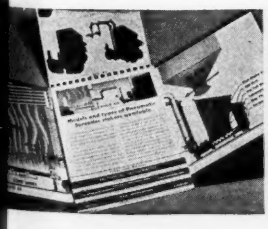
Front of boiler, showing the coal-conveyor tubes, clean-out doors, and controls. The boiler can readily be hand-fired in case of power failure.



Three low-pressure forced draft fans are located in the rear of the boiler with ducts under the floor of the last pass. Each fan furnishes air to a separate section of the grate. This arrangement permits cleaning one section of the grate at a time. Cleaning is done easily and without loss of pressure.

P. S. Installation in Hartsville, S. C. Print and Dye Works

The conveying worms of the three Iron Fireman Pneumatic Spreader stokers are installed through the front wall of the coal bunker. The conveying mechanism is located 12 feet from the boiler front, and coal is unloaded from cars directly into the bunker. The worms carry the coal from the bunker to the transfer housings, where hot furnace gases at high-velocity pick up the coal and convey it through pipes to nozzles, which distribute it uniformly to the fire-bed. The units are so arranged that the three nozzles may be operated simultaneously or separately, according to steam requirements. Both coal and air are automatically controlled —the requirements being set by the demand for steam. Very little attention is required, other than periodically cleaning the fires.



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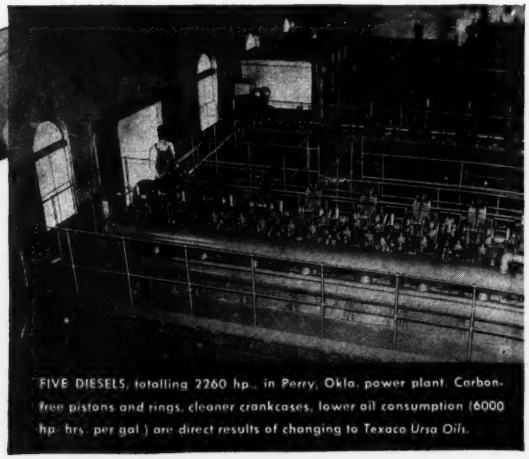

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MARCH, 1942

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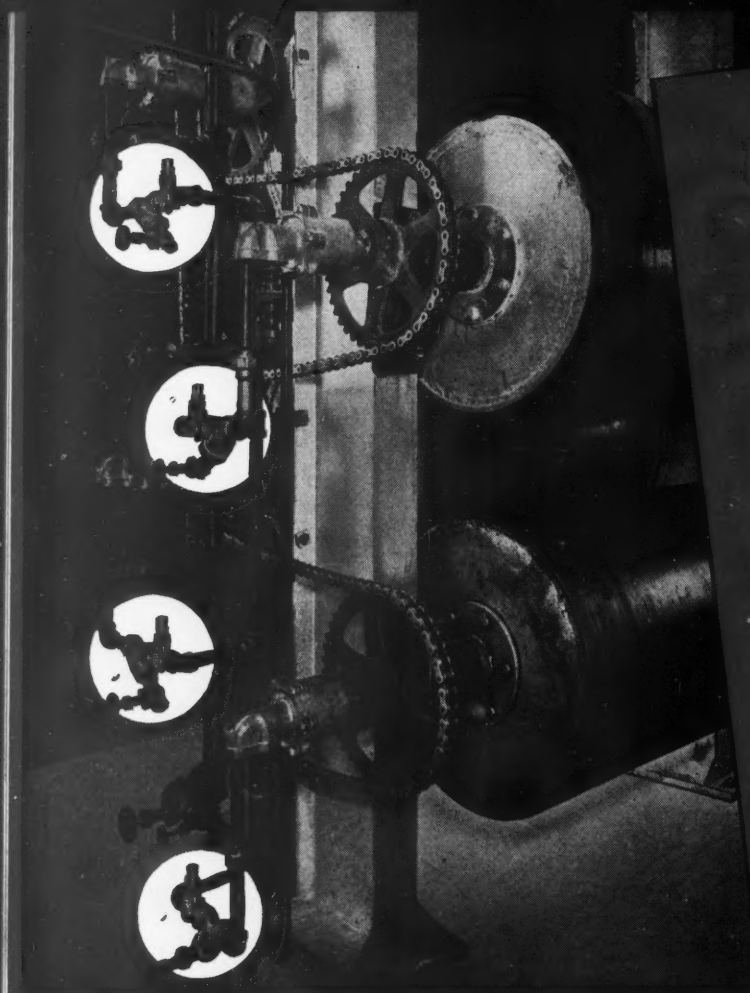

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Why not find out how Yarway Traps can assist you in *keeping your steam-heated equipment at top performance?* Find out about Yarway's *fuel economy,* their *saving in valuable space* around machines, their *low maintenance cost,*—and the fact that they usually *cost no more to buy than to repair ordinary traps.* More than 130,000 Yarway Impulse Traps have been purchased to date. Ask your Mill Supply Dealer, or write for Bulletin T-1736.

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YARWAY IMPULSE STEAM TRAP

WHAT LEADERS SAY

Voluntary Censorship—How It Works

Moffett Studios

By KINGSLEY L. RICE

EVERYONE in America has an interest in censorship for it affects to some degree radio programs, the news you read in the daily press, the articles in magazines, and both the editorial and advertising pages of general and engineering magazines. You may have noticed or will notice from now on that certain details to which you have been well accustomed are omitted or made less specific. Again there will doubtless be plant descriptions which won't give the name or exact location of the plant.

These restrictions are essential to the complete and whole-hearted co-operation which all branches of the press are giving to the Office of Censorship. On the whole, however, omission of details requested by military or naval intelligence officers will not impair the technical value of articles, nor limit vital and practical information which engineers need today more than ever before to ensure success in the job of supplying power and more power, so essential to win the battle of production.

On the other hand, you may occasionally see articles which raise in your mind a question as to whether the editors were wise in making the information public. You can rest assured that they will not take the slightest chance of publishing anything which could possibly aid our enemies, and, that every article about which there is doubt will be approved by the proper authority before publication.

The Office of Censorship in Washington is a thoroughly American institution in policy, conception and practice. Amazing as it may seem, domestic radio and press censorship is on a voluntary basis. In dictator countries the very word "censorship" means terror, coercion, the loss of free expression and the whip of a Gestapo. In America, "censorship" means simply co-operation, teamwork and self-discipline for the common cause.

It is inspiring to see at first hand how editors, publishers and radio managers have "pitched in" with enthusiasm to make voluntary censorship work. Imagine the self-control required of a hard-boiled city editor, who for years has been trained to get and print all the news regardless of who it hits and who considers suppression of a front page story sacrilegious, in keeping a big scoop under cover until the Army or Navy gives it the O. K. Engineering editors too have been leaning over backwards to keep out of their columns information which might help a saboteur.

Office of Censorship was created by Presidential order to cover international communications and was voluntarily extended to domestic news. Byron Price was brought from his position as Chief of the Associated Press, famous newspaper wire service, to head the new office as Director of Censorship. He is an able, experienced business man and skillful organizer with the qualities of leadership which are winning wholehearted co-operation of his growing staff and the many government officials who come into the censorship picture.

John H. Sorrells, Mr. Price's chief assistant, and formerly executive editor of the Scripps-Howard Newspapers, is an untiring worker, a diplomat with a nationwide acquaintance in press circles and with a broad understanding of business problems. He is also ideally fitted for his important assignment.

N. R. (Nat) Howard is chief assistant in the Press Division and his reputation as a writer and executive is so well established that leaving his position as editor of the Cleveland News for the duration serves at one and the same time as an indication of the importance of censorship and the patriotism of the press. These three are typical of the calibre of men who administer American censorship and it augurs well for the effectiveness and success of the enterprise.

While Wartime Censorship will mean a restriction of certain kinds of information, it will not mean a blackout of news or vital production information, nor restrictions on the right of individual expression. There is no censorship of opinion. There is a clear understanding in Washington of the need for releasing every possible bit of news to keep the public informed of war progress. Further, there is full appreciation of the fact that the battle of production depends on quick, accurate and complete dissemination of technical information.

Organizing the censorship plan involves many complications and for a short while you may see inconsistencies, although these will soon disappear.

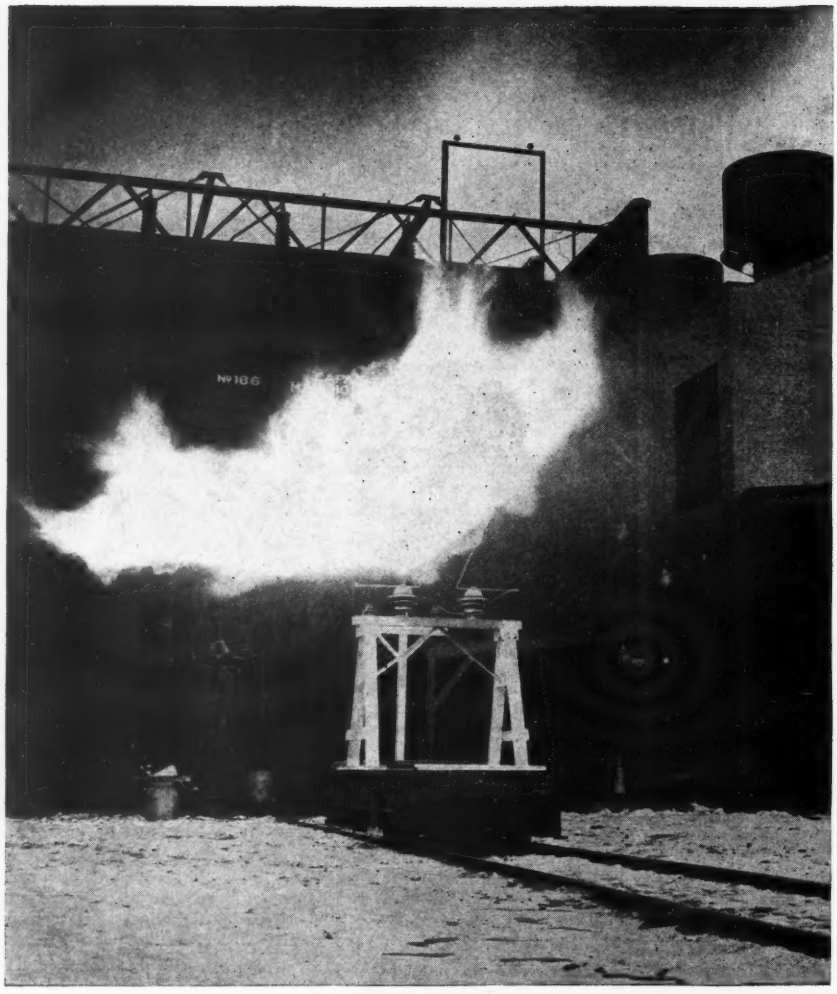
We in America can well feel proud and gratified that it is possible to set up and successfully operate a voluntary censorship. It carries a great hope for the future to know that plain citizens can work together on so complicated a project in a spirit of co-operation, self-sacrifice and mutual trust. And it *is* working.

KINGSLEY L. RICE, president of the Technical Publishing Co., publishers of Power Plant Engineering, and Chairman of the Promotion Committee of the Associated Business Papers, was, because of his broad background and wide experience in the technical publishing field, called to Washington late in January to assist the Director of Censorship in formulating a plan for censoring production information vital to industry and of particular concern to the business and technical press.

Byron Price, appointed Director soon after the office was created by Executive Order in December, and, cognizant of the conflicting needs of different media such as the movies, radio, newspapers and the business press, laid plans for each branch to be administered within the broad outlines of the Executive Order by men experienced in, and familiar with, the particular needs and problems of that section.

The problem, from the standpoint of the business press section, was to prevent the enemy from acquiring strategic production and industrial information without withholding information vital to American industry and business. Production and industrial information embraces: news and details of specific plants; statistics and figures on production, resources, machinery and critical materials; and technical information on design and processes. The plan for which Mr. Rice was called to Washington to help formulate, will be administered by Mr. Frank Tighe, formerly editor of the Automobile Trade Journal, and recently appointed to the Office of Censorship.

Mr. Rice graduated from Northwestern University following many months' service in France during the first World War. After several years of varied business experience he joined the Technical Publishing Co. and was elected president in 1938 following the death of Mr. E. R. Shaw.



TWO MILLION-KW. SHORT

THIS shows what happens when 2,000,000 kilowatts of electrical energy are let loose in air. It is a photograph taken at the Westinghouse high power testing laboratory at East Pittsburgh on January 22 when a current involving some 2,000,000 kw. was made to arc across a horn gap in air. At the start the horn gap was shorted by a small piece of iron wire. When the full output of the test generators was turned loose on this piece of wire, it, of course, vaporized in an instant of time but the power arc, thus initiated, under a potential of some 138,000 v., surged upwards in a 20 ft. waving, flaming, thundering mass of intensely hot ionized gas, that all but took away the breath of the spectators. The arc held for almost three seconds before it broke under the attenuating force of its own heat but in those three seconds, power measurements showed that some 300 kw-hr. of electrical energy were dissipated. At the average consumer cost of power, say 4 cents per kw-hr. approximately $12.00 worth of electricity was used. In those three seconds the test generators slowed down to such an extent that a full half hour was required to restore their speed to the normal 514 r.p.m. The two generators are rated at 60,000 kw. apiece, but the stored-up energy contained in their thousand-ton rotating masses is such that for the fraction of a second that the short circuit lasts, they deliver an amount of energy equivalent to twice all the power produced at any instant at Niagara Falls; putting it another way, enough power to light a string of fluorescent lamps to girdle the earth twice at the equator. Further details of this high power test set and its performance will be found on page 79

WITH THE EDITORS

◆ **NEEDLESS SECRECY** . . . It is probably inevitable but unfortunate that many individuals in responsible positions in industry should take advantage of the times in maintaining needless secrecy over things that fundamentally are not of a secret nature and that would better, for the sake of everybody concerned, be disclosed to those interested in them. In mentioning this here, we refer specifically to power plants. There is very little of a secret nature about a modern power plant and when new plants are built these days there is no reason why the engineering details of these plants should not be described in reputable engineering and technical journals. Indeed, there are numerous advantages to be gained from such publicity because possible unusual methods employed in such plants either for increasing the fuel efficiency or for conserving vital material would be of direct benefit to others confronted with the need for expanding their power generating facilities. If the faith which we have had in the value of the interchange of ideas was worth what we claimed it be in peacetime, then certainly it should be doubly valuable in wartime when the need for reducing waste and conserving material is so much more vital.

An idea in one plant, may be extremely valuable to that plant but if the idea is of such a nature that it could be put in use in other plants, it would be a thousand times more valuable to the nation if it were adopted in a thousand plants. Yet, how are the engineers in the other 999 plants going to know about it if the idea is not given general publicity?

In making this plea for an intelligent attitude towards publicity in the power plant industry we do not dispute the need for effective censorship where censorship is vital. In the case of large power plants serving industries of great strategic importance, it may well be desirable to withhold the names and locations of such plants, but certainly there is no need to suppress the engineering design.

◆ **MAKING THE BEST OF IT** . . . Some very interesting things are being done in the power plant field as a consequence of the scarcity of certain materials and the difficulty of getting new equipment. In a case that was recently brought to our attention, a power plant was built for a small paper mill in which practically all of the equipment and much of the material used was second hand. Some old boilers were obtained, an old engine still on the premises was reclaimed and put in commission, a generator was found that had seen long service but still in excellent condition—even the switchboard and the bus bars were second hand. A plant of this kind, properly assembled, may not knock out a kilowatt for 10,000 B.t.u. but that is not necessary. If it produces power reliably it fulfills a very distinct need and it is one way of getting around priorities. The story of how this plant was constructed, how and where the material and equipment were obtained, the headaches involved in its assembly would be of interest to thousands of power plant men throughout the country.

◆ **A LARGE EXAMPLE** . . . A notable example of what can be done in making use of old equipment to supply much needed power producing facilities is had in a plant now being built at Freeport, Texas, where the Defense Plant Corporation is constructing a large magnesium plant. The power requirements of this plant will be over 100,000 kw. of firm power. Unfortunately, this isolated section of the Texas Coast line is so far removed from the existing power supply that a new plant was a necessity. Even with A-1-a priorities, at least 2 yr. would have been required for fabricating and installing a complete new generating station. As a result of this situation leading power plant engineers were called in to find a way out of this apparently hopeless situation.

After weeks of persistent investigation a plan was developed for assembling a combination of used and partly fabricated new equipment which it is believed will solve the problem. A used but entirely serviceable 45,000-kw. low-pressure turbine was obtained from Detroit. An almost perfect mate to this machine was found in New York City. Although actually in service when the plan was developed, it was used largely for standby service. A battery of old low pressure boilers was also obtained at New York and at a turbine manufacturing plant a largely fabricated topping unit, undertaken once as a stock model, was discovered.

To make a long story short, by this plan it is expected that a complete power plant of 125,000 kw. will be ready in less than one year—the first 85,000 kw. will be ready in 8 mo.

◆ **RITUAL** . . . Despite the value of and the obvious interest in large engineering society conventions such as that of the American Institute of Electrical Engineers reported on page 30. of this issue, in recent years they have been beset by entirely too much of what might be called "ritual." A program is arranged, certain individuals are asked to present papers and these papers are presented at certain sessions. The papers are prepared long in advance and the supposition is that the members present have read the papers before their presentation.

Some 10 or 15 min. is allowed for the presentation of a paper that ordinarily might require an hour and five or six such papers are presented in rapid succession in the course of an hour or two. In many cases the papers are of a highly specialized nature and only a handful of the audience would be competent to discuss them, even if they had read them. As a consequence many of these sessions are uninteresting and largely sterile, that is they stimulate little if any discussion. The author of the paper presents the paper, calls for a few slides and then if he is not through in 10 min., the chairman reminds him his time is up. So he closes hurriedly, and as he walks off the stage is given a half-hearted round of applause whether he deserves it or not.

Rarely, if ever, is there hissing and sometimes we feel that perhaps that is just what is needed. Controversy stimulates interest and ideas. No meeting is ever quite so interesting as when someone in the audience gets up and says he doesn't believe what the author says, but such events are quite rare in large engineering conventions. The meetings at such conventions which are most interesting and most stimulating are the informal "conferences" where no set papers are delivered and where the meeting is open to general discussion from the start. If the ponderous technical papers presented at engineering conventions have definite value let them be incorporated in the published proceedings by all means, but it is often a waste of everybody's time to present time to an audience that either does not understand them or does not care to listen. A little less ritual and perhaps a little more name calling would be desirable.

◆ **'TAIN'T SO** . . . It is strange how rapidly certain rumors travel across the country. Upon several occasions recently in our travels we have come across a strange rumor regarding fluorescent lighting. There is utterly no foundation to the rumor but it is quite evident that many non-technical people are ready to believe it. This rumor holds, or at least brings up the question as to whether it is true that fluorescent lighting installations have the effect of creating sterility in young women workers exposed to them. In one case that was brought to our attention the question was asked by someone connected with a large factory construction project in a letter to the director of research of one of the large lamp works. His reply was, of course, that there was utterly no truth in such an assertion—that fluorescent lamps operate by virtue of ultra-violet radiation within the glass tubes and that even if such ultra-violet radiation did pass through the walls of the tube, which it does not, there is no evidence that ultra-violet light induces sterility in human beings.

Where this fantastic rumor originated it is difficult to discover but we place it on record here to warn anybody hearing it against believing it.

Cleveland's new Lake Road Generating Station adds 37,500-kw. to the electric generating capacity of the city's system, with plenty of room for expansion, and employment of a topping unit augments steam capacity of the old plant. Architecture and surroundings simulate features of public buildings, and coal delivery, piping and electric connections with old plant are completely underground. Heat rate on condensing unit is 12,725 B.t.u. per kw-hr.

INCREASED ELECTRIC POWER FOR CLEVELAND

WHEN THE LOAD on the old municipal power plant in Cleveland, Ohio, outgrew the capacity of its units, one of the serious problems confronting the city was to find a suitable location for a new plant with room to expand as future requirements presented themselves. The old plant is located on the south side of the lake shore road at East 53rd Street, and the city property was so limited that the possible extension of the building on that side of the road was not sufficient. Naturally the engineers looked across the street where they had dumped their ashes for years, thus extending the city land and pushing the lake shore a little closer to Canada, but the city authorities held out against erecting a plant on property intended for a lake shore park until they were won over by plans for a building that ranked in beauty with city halls, libraries, museums and other structures of which the city of Cleveland is proud. Then, too, the engineers did not forget the landscaping with tall hedges behind which workmen's cars and trucks can be parked without detracting from the beauty of the surroundings. There is to be no railroad connection on that side of the boulevard, nor will there be any overhead pipe lines or electric cables. Those plans demonstrated that a power plant could be a structure of beauty as well as utility, and they have now been converted into a real structure filled with modern high-efficiency power generating equipment with provision made for ample expansion for years to come.

Fig. 1. Two main generating units are located in the turbine room, consisting of a 25,000-kw. condensing unit (left) and a 12,500 topping unit

As presently constructed, the plant consists of one 12,500-kw. topping turbine and one 25,000-kw. condensing turbine. These are supplied with steam by three pulverized coal fired steam generators. Plans of the ultimate plant call for the addition of three more turbo-generators and three more steam generators, thus carrying out the unit design with one steam generator as a spare. The topping turbine which receives steam at 650 psi. 825 deg. F. exhausts at 250 psi. through the tunnel piping to the piping system in the old plant where there are six turbo-generators with a total capacity of 50,000 kw.

The piping system is provided with a reducing station by means of which the topping machine can be bypassed and the steam delivered from the boilers to the old plant at the proper pressure and temperature. Eventually it is expected that the old plant will be used for standby service only.

Fig. 2. Operating aisle in boiler room gives access to principal manual boiler controls, coal feeders and a full view of the instrument board for the adjacent unit

In architectural design, the plant presents the appearance of a public building rather than an industrial structure. The smoke stacks are only as high as is considered necessary to carry the gases away from the building and grounds so they do not enter prominently into the visual picture presented to the man on the street. Since the basement floor is 15 ft. below the surface level of Lake Erie, the structural design of this section of the building is somewhat like that of a boat.

Throughout the building extensive use is made of acoustic material to prevent the spread of noise from one department to another. In the turbine room, and feed pump room, for instance, a 1-in. layer of Acoustone is used on the side walls and 2 in. of Thermax on the ceilings, also in the offices Acoustone is used in the walls.

Coal is conveyed by means of a belt system running through a tunnel from the railway receiving and crushing station serving the old plant. At the new plant, the coal is elevated by belt conveyors and distributed in the boiler house bunker or discharged by gravity to the storage yard. At present all coal is crushed at the old plant to a fineness suitable for the pulverizers. However, provision has been made in the coal handling equipment arrangement which, through the installation of an additional crusher at some future date, will permit the postponement of the crushing of the stocked coal until the time of reclaiming. This future crusher will be so positioned as to permit its use in connection with any water-borne coal.

The new station is provided with a feeder control board located in the upper part of the boiler house through which station transformers are supplied. Power supplied to the outside load is conducted over underground cables to the old station for distribution throughout the city.

Condensing water for the 25,000-kw. turbine comes directly from the lake through traveling screens to the suction of two vertical circulating pumps and returns to the lake after serving its purpose in the plant. Two other vertical pumps also use this supply for furnishing house service water. These deliver the water through filters and strainers to equipment required to be cooled and other services where treated or purified water is not required.

At the intake house for the circulating water, the Rex screen made by Chain Belt Co. is of special design in that the water flows through both the rising and descending sections of the traveling screen with the discharge coming off at right angles to the intake from the space between the rising and descending sections. Provision, of course, is made for carrying away the debris but the arrangement prevents trash that clings to the intake side of the screen through the washing process from being carried into the circulating system.

Through the pipe tunnel connecting with the old plant, which carries the main steam pipe and condensate returns, the new plant receives its city treated water used for drinking purposes, sanitary water for toilet use and raw city water which is used for boiler feed make-up.

Steam Generation

Steam is generated in three 3-drum Foster Wheeler boilers each with a continuous rating of 300,000 lb. per hr. of steam at 665 psi. 835 deg. F. and a maximum 2-hr. peak of 350,000 lb.

These boilers are designed with a relatively large convection superheater to produce the desired steam temperature at the lower point of the control range. At the higher loads, the gases are bypassed around part of the superheater by means of a set of dampers. At intermediate loads, the required final steam temperature is obtained within the control range by regulating the dampers so that the proportionate amount of the total gases flowing over the superheater will give the desired temperature.

The superheat control dampers as well as the combustion control equipment is operated entirely by electricity which eliminates the use of auxiliary air or hydraulic

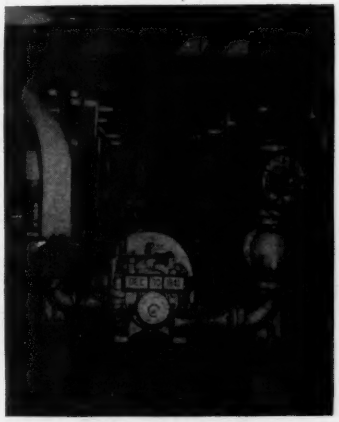


Fig. 3. Boiler feed pumps, three electrical and one turbine driven

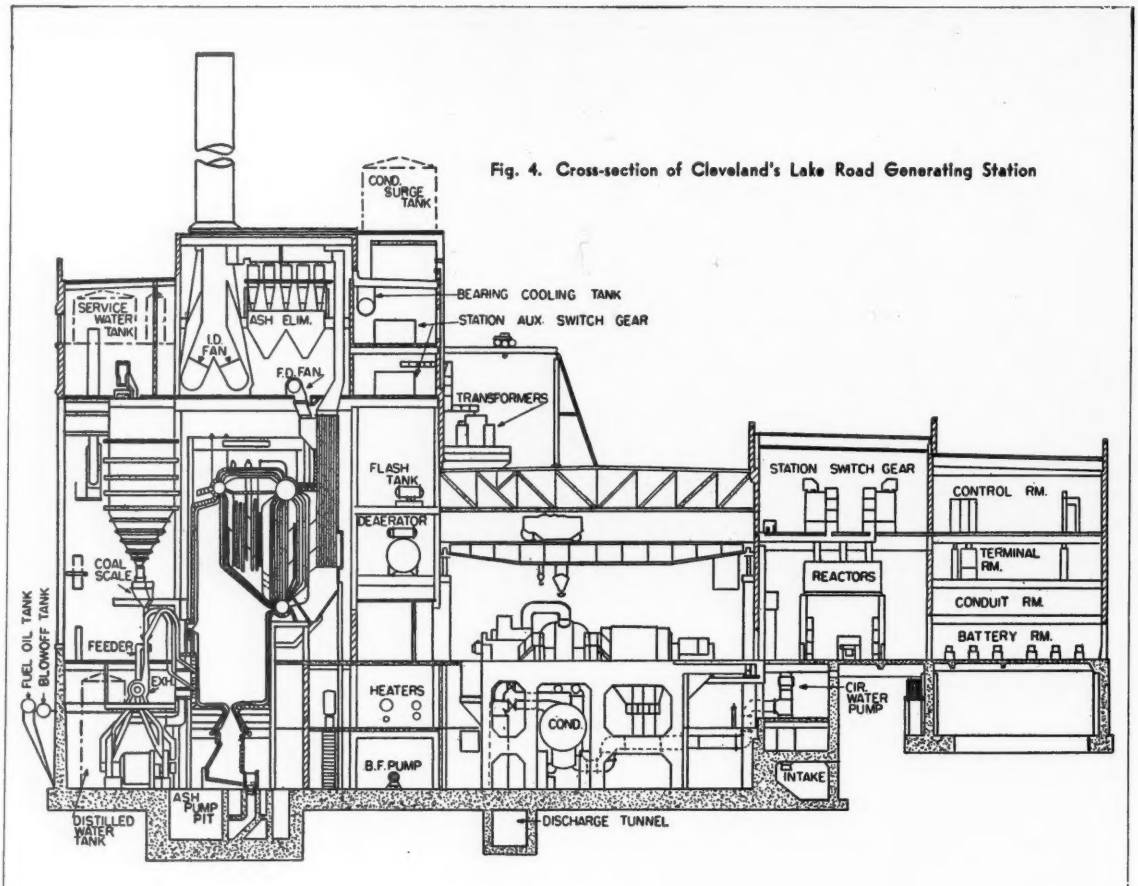


Fig. 4. Cross-section of Cleveland's Lake Road Generating Station

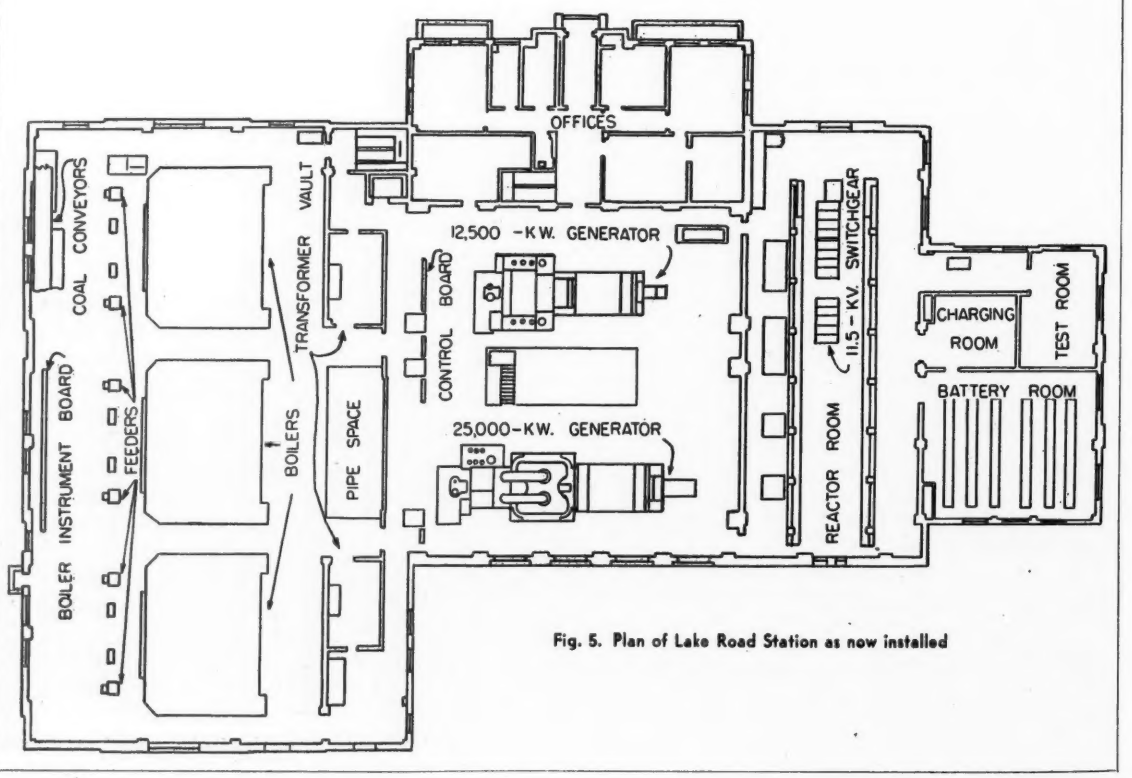


Fig. 5. Plan of Lake Road Station as now installed

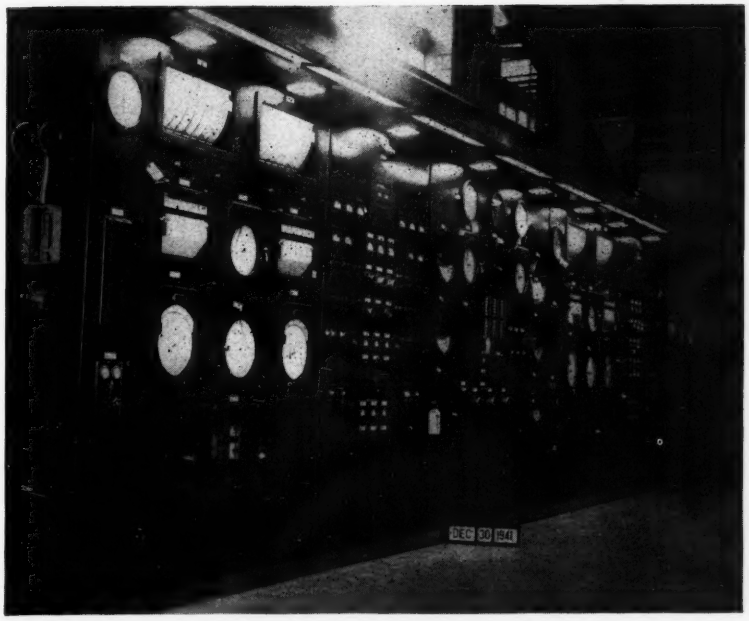


Fig. 6. Boiler room control board showing mechanical and electrical panels

power supply. This control equipment, the product of the General Regulator Co., is arranged for remote operation by push-button and includes position indicating meters and reversing switches for the regulators.

For each boiler there are two Richardson automatic scales that feed conical pulverizers, each with a capacity of 9½ t. of bituminous coal per hour. These discharge into the furnace through four intertube burners provided with crossover fuel piping which permits of flexibility in handling changes in loads. Bare tangent waterwalls enclose the furnace on all four sides and the roof. Tubes of the front and rear walls are turned inward horizontally at the bottom to form the furnace floor on each side of a discharge throat through which slag drops continuously into a water-filled slag hopper. The floor tubes are shielded from the molten slag by a blanket of chrome ore which is held in place by short metal lugs welded to the tubes at frequent intervals and lined up across adjacent tubes to form continuous dams across the width of the furnace, parallel to the slag throat.

The slag is delivered by an Allen - Sherman - Hoff hydraulic system to an ash silo from which it is disposed by truck. Dust is collected and delivered to another silo by means of a United Conveyor Corp. pneumatic system.

For each boiler two Sirocco type forced draft fans are provided, each driven by a 125-hp. Allis-Chalmers motor. Induced draft is supplied by two Sirocco induced draft fans per boiler, each fan having a double drive consisting of two Allis-Chalmers motors, one a 250-hp. and the other a 200-hp., which are under the control for the combustion regulating system.

One stack is provided for each boiler, this being constructed of welded sheet steel lined with 2½ in. of reinforced gunite. The diameter of the stack is 8 ft., height above the boiler house roof 60 ft. or 175 ft. above the city datum. The effective area is 46 sq. ft., sufficient to handle 122,000 c.f.m. of gas, which is the maximum rating of one boiler, at a velocity of 44 ft. per second.

Make-up feedwater amounts to about 3 per cent of the total evaporated. This comes from the city mains to evaporators. The evaporated vapors are condensed in the deaerating heaters. Here also the necessary feedwater treatment chemicals are introduced.

Feedwater

All condensate is, of course, returned to the boiler feed system, the equivalent in condensate of the steam delivered from the topping turbine to the old plant being returned through the tunnel. In the condensing turbine cycle, steam for heating the feedwater supplemented by the exhaust from auxiliaries is bled at four points from the 25,000-kw. condensing turbines, the full load pressures being 161, 74, 22 and 7 psi. The first stage of heating, when operating at full load, raises the condensate temperature from 84 deg. to 169 in the low-pressure heater with steam from the fourth bleed point.

From the low pressure heater water is pumped to the deaerating heater which takes both bled and auxiliary exhaust steam at 22 psi. and raises the temperature to 233 deg. From here the boiler feed pumps deliver to the intermediate pressure heater where the temperature is raised to 293 deg. by steam bled at 74 psi., then directly through the high-pressure heater using bled steam at 161 psi. to raise the temperature to 350 deg. at which it is delivered directly to the boiler. Drains from the h.p. heater are delivered to the steam side of the i.p. heater and

Fig. 7. Control panels for main turbines are located along the east end of the turbine room

Fig. 8. Aisle on fan floor showing forced and induced (left) draft fans and dust precipitators (above)

from this unit go to the deaerating heater where they join the feedwater circuit.

While there is a complete crossover piping system between the two turbines, under balanced conditions no flow takes place and the feed heating arrangement in the topping turbine cycle differs in that the l.p. and the i.p. heaters are eliminated, and the h.p. heater is heated by steam from the exhaust of the topping turbine at 250 psi. and 611 deg.

A distilled water tank is provided to receive condensate from the turbine packing glands and the overflow from the condensate surge tank. From the distilled water tank, pumps deliver the water to the surge tank, the gland seal tank and, in emergency, to the boiler feed pump suctions.

Two cross connected feedwater headers are provided, one 10 in. the other 8 in., with arrangements for automatic feeding from the main header and from either header through separate piping to each boiler with the hand control valves connected to floor standards located on the operating floor near the mirror used in connection with the bi-color gage glass.

Steam generated at 665 psi., 835 deg. F. is delivered through 10-in. leads, provided with suitable metering equipment, to 14-in. headers located near the ceiling of the operating room. From these headers, 10-in. leads carry the steam to the turbines. The steam is measured and strained before it enters the turbine. The high pressure headers have a 12-in. cross connection between them and two 12-in. leads connecting into a 14-in. line to a pressure reducing station to be used for supplying steam for the old plant when the topping turbine is not in service. Other connections from these headers are made to turbine driven boiler feed pump, dual driven exciter and the condenser air-ejector. Suitable provisions are also made for carrying away the drips.

Turbine-Generator Units

The electric generating equipment consisting of two main turbine generators and their auxiliaries is located in the middle section of the building between the boiler room and the electrical section of the plant. This room is spacious and conveniently arranged for handling all parts of the generating units with a 75-t. traveling crane provided with an auxiliary 15-t. hook. Between the units is an open space in the floor which permits the crane to handle equipment on the condenser floor.

The topping or superposed unit is located nearest the front of the plant and provisions have been made in the foundation and building structure which will make possible its replacement by a condensing unit of twice its size without excessive structural work. This change may take place in the future when the new plant has been enlarged to the point where it can handle the entire load on the system.

Of the main two turbine-generator units installed, one is a 25,000-kw., 80 per cent p.f., condensing, tandem-compound unit and the other 12,500-kw., 80 per cent p.f., non-condensing, high-back pressure (topping) unit. Each unit operates at 3600 r.p.m. and is designed for a normal throttle steam condition of 650 psi. ga., 825 deg. F. The normal exhaust pressure is 1 in. Hg. abs. for the condensing unit and 250 psi. ga. for the non-condensing unit. The electrical conditions are 11,000 v., 3-phase, and 60 cycle for both units.

The 25,000-kw. condensing turbine is of the impulse reaction type consisting of a Rateau stage followed by 29 reaction stages in the high pressure element and 7 double flow reaction stages in

Fig. 9. Vertical circulating water pumps are located on floor level +1, being in line with the condenser they are subjected to little more than friction load

the low pressure element. All of the high pressure steam passes through the Rateau stage when carrying loads up to 18,900 kw. For higher loads up to approximately 25,000 kw., the steam bypasses the Rateau stage and enters the first stage of reaction blading. When the unit is carrying loads greater than 25,000 kw., steam by-passes the Rateau stage and first ten reaction stages and enters the eleventh reaction stage. This arrangement of stages and steam control gives an efficiency over the full capacity range of the unit that is most suitable for the expected loading of the unit.

The tandem-compound arrangement with a double flow, low pressure element keeps the leaving loss low even with the high vacuum expected. This construction does not require unusual exhaust blade tip speeds, allows the use of relatively small turbine spindles and high pressure cylin-

FLOW DIAGRAM AND HEAT BALANCE

Key	Units	1/2 load	3/4 load	4/4 load
1	Kw.	18750	25000	33200
2	lb/hr.	218361	297371	395137
	Pres.	265	265	265
	B.t.u.	1334.84	1327.88	1323.45
	°F.	632	620	611
3	lb/hr.	2183.61	2973.71	3951.37
	Pres.	1" Hg.	1" Hg.	1" Hg.
	B.t.u.	57.99	57.99	57.99
	°F.	90	90	90
4	lb/hr.	4144	5653	7519
5	lb/hr.	276250	376875	501250
	Pres.	665	665	665
	B.t.u.	1419.00	1419.00	1419.00
	°F.	825	825	825
6	lb/hr.	18266	24874	33115
	Pres.	22	22	22
	B.t.u.	1327.88	1327.88	1323.45
7	lb/hr.	280394	382528	508769
	B.t.u.	201.33	201.33	201.33
	°F.	233	233	233
8	lb/hr.	276250	376875	501250
	Pres.	265	265	265
	B.t.u.	1334.84	1327.88	1323.45
	°F.	632	620	611
9	kw.	6250	9375	12500
10	lb/hr.	4144	5653	7519
	Pres.	22	22	22
	B.t.u.	1158.10	1158.10	1158.10
11	lb/hr.	4237	6000	8014
	B.t.u.	272.61	272.61	272.61
	°F.	303	303	303
12	lb/hr.	280394	382528	508769
	B.t.u.	321.63	321.63	321.63
	°F.	350	350	350
13	lb/hr.	707	956	1283
	Pres.	22	22	22
	B.t.u.	1158.10	1158.10	1158.10
14	lb/hr.	35386	48630	64984
	Pres.	265	265	265
	B.t.u.	1334.84	1327.88	1323.45
	°F.	632	620	611
15	lb/hr.	4144	5653	7519
	B.t.u.	38.04	38.04	38.04
	°F.	70	70	70
16	lb/hr.	4851	6609	8802
	B.t.u.	201.33	201.33	201.33
	°F.	233	233	233
17	lb/hr.	4237	6000	8014
	Pres.	70	70	70
	B.t.u.	1334.84	1327.88	1323.45
18	lb/hr.	35386	48630	64984
	B.t.u.	381.60	381.60	381.60
	°F.	414	414	414
19	lb/hr.	1300	2000	2400
20	lb/hr.	118911	175815	238653
	Pres.	665	665	665
	B.t.u.	1419.00	1419.00	1419.00
	°F.	825	825	825
21	lb/hr.	100282	148466	197985
	B.t.u.	112.41	129.90	136.55
	°F.	144	162	169
22	lb/hr.	7416	7543	8485
	Pres.	22	22	22
	B.t.u.	1188.2	1208.00	1158.10
23	lb/hr.	1300	2000	2400
	Pres.	22	22	22
	B.t.u.	1158.10	1158.10	1158.10
24	lb/hr.	120211	177815	241053
	B.t.u.	201.33	201.33	201.33
	°F.	233	233	233

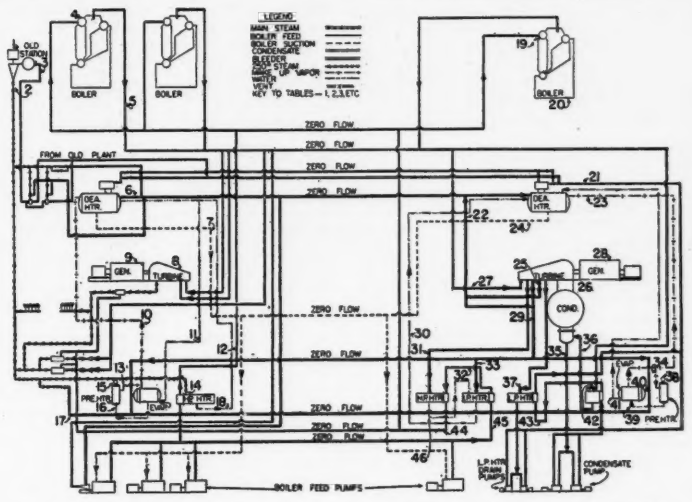


Fig. 10. Heat balance diagram of Lake Road Generating Station. Tables below are keyed to diagram and are calculated for three different load conditions

Key	Units	1/2 load	3/4 load	4/4 load
25	lb/hr.	.....	.....	8485
	Pres.	.....	.....	22
	B.t.u.	.....	.....	1158.10
26	lb/hr.	93992	136642	181100
	Pres.	1" Hg.	1" Hg.	1" Hg.
	B.t.u.	997.50	997.50	997.50
27	lb/hr.	118111	175015	237853
	Pres.	665	665	665
	B.t.u.	1419	1419	1419
	°F.	825	825	825
28	Kw.	12500	18750	25000
29	lb/hr.	12076	17121	17224
	Pres.	38	55.5	74
	B.t.u.	1188.20	1208.00	1233.00
30	lb/hr.	9689	17451	29373
	B.t.u.	232.89	256.90	276.40
	°F.	264	288	307
31	lb/hr.	6553	10228	14959
	Pres.	82.8	120.7	161
	B.t.u.	1247.50	1268.00	1294.00
32	lb/hr.	120211	177815	241053
	B.t.u.	229.06	243.18	262.20
	°F.	261	275	293
33	lb/hr.	3136	7223	14414
	Pres.	38	55.5	74
	B.t.u.	1188.2	1208.00	1233.00
34	lb/hr.	222	341	410
	Pres.	22	22	22
	B.t.u.	1158.10	1158.10	1158.10
35	lb/hr.	94792	137442	181900
	B.t.u.	46.02	46.02	46.02
	°F.	78	78	78

Key	Units	1/2 load	3/4 load	4/4 load
36	lb/hr.	800	800	800
	Pres.	1" Hg.	1" Hg.	1" Hg.
	B.t.u.	45.66	45.66	45.66
	°F.	78	78	78
37	lb/hr.	5490	11024	16085
	Pres.	3.6	5.25	7.0
	B.t.u.	1058.70	1076.00	1092.00
38	lb/hr.	1300	2000	2400
	B.t.u.	38.04	38.04	38.04
	°F.	70	70	70
39	lb/hr.	1522	2341	2810
	B.t.u.	201.33	201.33	201.33
	°F.	233	233	233
40	lb/hr.	1524	2355	2810
	Pres.	38.0	55.5	74.0
	B.t.u.	1188.20	1208.00	1323.45
41	lb/hr.	1524	2355	2810
	Pres.	38.0	55.5	70.0
	B.t.u.	232.89	256.90	276.49
	°F.	264	288	307
42	lb/hr.	800	800	800
	Pres.	665	665	665
	B.t.u.	1419	1419	1419
	°F.	825	825	825
43	lb/hr.	94792	137442	181900
	B.t.u.	57.61	54.00	52.06
	°F	90	86	84
44	lb/hr.	120211	177815	241053
	B.t.u.	281.56	298.12	321.62
	°F.	313	330	350
45	lb/hr.	120211	177815	241053
	B.t.u.	201.33	201.33	201.33
	°F.	233	233	233
46	lb/hr.	6553	10228	14959
	B.t.u.	284.40	312.90	336.45
	°F.	256	345	364

Summary—Station Performance—12,500-Kw. Unit

	Units	1/2 Load	3/4 Load	4/4 Load
Power delivered by superposed unit	Kw.	6250	9375	12500
Power delivered by low-pressure units	Kw.	18750	25000	33200
Total power delivered	Kw.	25000	34375	45700
Heat absorbed in boiler	B.t.u./hr.	303852404	414531594	551333965
Plant heat rate (gross) 86 per cent boiler efficiency	B.t.u./hr.	14132	14022	14027
Assumed operating efficiency	%	93.0	93.5	94.0
Plant heat rate at assumed operating efficiency	B.t.u./kwh.	15196	14997	14922
Coal consumption basis of assumed op. eff. (12,500 B.t.u./lb.)	lb./kwh.	1.216	1.200	1.194

Summary—Station Performance—All 25,000-Kw. Units

	Units	1/2 Load	3/4 Load	4/4 Load
Power delivered by unit	Kw.	12500	18750	25000
Heat absorbed in boiler	B.t.u./hr.	135527050	197454277	259914211
Heat rate of turbo-generator	B.t.u./kwh.	10842	10531	10396
Plant heat rate (gross) 86 per cent boiler eff.	B.t.u./kwh.	12606	12245	12089
Assumed operating eff.	%	94	95	95
Plant heat rate at assumed op. eff.	B.t.u./kwh.	13411	12889	12725
Coal consumption based on assumed op. eff. (12,500 B.t.u./lb.)	lb./kwh.	1.0729	1.0311	1.0180

Major Items of Equipment in Cleveland's Lake Road Generating Station

Boilers—3, Foster Wheeler bent tube, pulverized coal fired. Oil burners for starting, 300,000 lb. steam per hr. at 665 psi. ga., 835 deg. F.

Combustion Control System—General Regulator Corp. Electrically operated.

Oil Pumps—2, Kinney dual motor driven horizontal centrifugal rotary, 25 gal. per min., 234 ft. head. Supply oil from the fuel oil tank to burner nozzles.

Coal Handling System—C. O. Bartlett & Snow Co., belt conveyor using Goodyear belts driven by Reliance motors.

Coal Pulverizers—6, Foster Wheeler, conical, rock wool lined, driven by Allis-Chalmers motors through Farrel-Birmingham Co. gears.

Coal Scales—6, Richardson Scale Co., automatic.

Induced Draft Fans—6, American Blower Co., Sirocco, each driven by 2 Allis-Chalmers motors, 250 and 200 hp.

Forced Draft Fans—6, American Blower Corp., 125-hp. Allis-Chalmers motor drive.

Ash Handling System — Allen-Sherman-Hoff Co., hydraulic.

Dust Conveying System — United Conveyor Corp., pneumatic.

Low-Pressure Heater — 1. Foster Wheeler, closed type for heating condensate from hotwell. 182,000 lb. of condensate per hr. Heat rise, 96 deg. F. to 168 deg. F. 15,500 lb. steam per hr. Turbine low pressure bleed at 7 psi abs.

Intermediate-Pressure Heater—1, Foster Wheeler, closed type for heating boiler feedwater. 228,000 lb. feedwater per hr. Heat rise, 233 deg. F. to 292.8 deg. F., 16,000 lb. steam per hr. Turbine low pressure bleed at 74 psi abs.

High-Pressure Heater — 1, Foster Wheeler, closed type for heating boiler feedwater. 510,000 lb. of condensate per hour from existing station. Heat rise 96 deg. F. to 350 deg. F. 65,000 lb. of steam per hr. Low pressure steam 250 psi. ga. at 600 deg. F.

High-Pressure Heater—1, Foster Wheeler, closed type for heating boiler feedwater. 228,000 lb. of feedwater per hr. Heat rise 292.8 deg. F. to 350 deg. F., 12,000 lb. steam per hr. Turbine high pressure bleed at 161 psi abs.

Deaerators—2, Cochrane vertical type for make-up water to evaporators, with vent condenser. 10,000 lb. of water per hr. at 70 deg. F.

Deaerators—2, Cochrane horizontal type with vent condenser. 300,000 lb. of condensate per hr. at 233 deg. F.

Master Control—S-C, The Swartwout Co. for feedwater steam to deaerators, desuperheater and pressure reducing valves.

Evaporators—2, Foster Wheeler, 10,000 lb. make-up per hour.

Boiler Feed Pumps—3, Ingersoll-Rand motor driven, 375,000 lb. water per hr. Discharge pres. 1020 psi. ga. Suction temperature 233 deg. F. 600-hp. Westinghouse motors.

Boiler Feed Pump—1, Ingersoll-Rand turbine driven with Westinghouse turbine. Turbine, 14,000 lb. steam per hr. at 650 psi. ga., 825 deg. F. Exhaust at 25 psi. abs. to deaerator pump. 375,000 lb. of water per hr. Discharge pressure 1020 psi. ga., suction temperature 233 deg. F.

Low-Pressure Heater—2, Ingersoll-Rand motor driven centrifugal drip pumps. 50 gal. per min. Water at 177 deg. F. Pumps condensate from low pressure heater back into the system at approximately elevation +15.

Condensate Pump—2, Foster Wheeler motor driven horizontal centrifugal, 440 gal. condensate per min. at 90 deg. F.

Condensate Return Pumps—2, Ingersoll-Rand steam turbine driven, 1200 gal. per min. at 100 deg. F. condensate; 2500 lb. per hr. of steam at 250 lb. per sq. in., 600 deg. F. Pump condensate from old station to the new deaerators.

Drip Tank Pumps—2, Ingersoll-Rand motor driven, horizontal, centrifugal, 25 gal. per min. of water at 210 deg. F.

Distilled Water Pumps—2, Ingersoll-Rand motor driven, horizontal, centrifugal, 600 gal. per min. condensate at 70 deg. F. Pump condensate from the discharge water tank located at elevation—15 ft. to the condensate tank located on the roof at elevation +115 and to the deaerator located in the pipe aisle at elevation +35 ft.

Boiler Water Recirculating Pumps—3, Hankison motor driven, horizontal, centrifugal. 15 gal. per min. at 508 deg. F., 100 ft. hd. Static suction head +2140 ft., static discharge head +2142 ft. Recirculate boiler water from the continuous blow-down on the boiler drum through chemical bottle into the boiler feed line near boiler feed nozzle.

Service Water Pumps—2, Sterling Pump Corp., motor driven, vertical. 2000 gal. per min. Water temperature average 60 deg. F. each. 150-hp. Westinghouse motors. Pumping water to the service water tank located at elevation +86 ft.

Twin Strainers—2, Elliott Co., 2000 gal. per min. each compartment. Strainers installed in the service water pipe line between service water pumps and service water tanks.

Rotary Self-cleaning Strainers—2, Blackburn-Smith, 2000 gal. per min. each. Strainers installed in the service water pipe line between service water pumps and service.

Sump Pumps—2, Sterling motor driven, vertical, centrifugal, 500 gal. per min. at 70 deg. F. Discharge from the main sump to the main discharge tunnel at elevation —1.

Elevator Sump Pump—1, Sterling motor driven, vertical, centrifugal, 20 gal. per min. at 70 deg. F., 45 ft. hd.

Cooling Water Pumps—2, Ingersoll-Rand motor driven, horizontal, centrifugal for fan bearing. 50 gal. per min. at 70 deg. F.

Sump Pump—1, Sterling motor driven vertical centrifugal coal hopper, 20 gal. per min. at 70 deg. F., 20 ft. hd.

Sluicing Pumps—2, Ingersoll-Rand motor driven horizontal, centrifugal. 1000 gal. per min. of water at 70 deg. F. 75-hp. Westinghouse motors.

Turbo-Generator—1, 25,000 kw. Allis-Chalmers condensing type with 4 bleed points, 240,000 lb. steam per hr. at 650 psi. ga., 825 deg. F., 11,000 v., 3600 r.p.m. direct connected exciter 100 kw., 200 v.

Turbo-Generator—1, 12,500 kw. Allis-Chalmers superposed type, 512,000 lb. steam per hr. at 650 psi. ga., 825 deg. F., 11,000 v., 3600 r.p.m., direct connected exciter.

Oil Coolers—2, Griscom-Russell closed type for 25,000 kw. turbo-generator oiling system. 330 gal. of water per min. at 85 deg. F.

Oil Coolers—2, Griscom-Russell closed type for 12,500 kw. turbo-generator oiling system. 200 gal. of water per min. at 85 deg. F.

Lubricating Oil Storage Tanks—2, De Laval Separator Co., 3600 gal. each. (1 dirty oil tank—1 clean oil tank.)

Exciter Set—1, Allis-Chalmers, duo drive, 300-kw. steam turbine, 400-hp. motor, 300-kw. d.c. generator.

Generator Air Cooler — 1, Griscom-Russell closed type for 25,000 kw. turbo-generator. 1100 gal. of water per min. at 85 deg. F.

Generator Air Cooler — 1, Griscom-Russell closed type for 12,500 kw. turbo-generator. 412 gal. water per min. at 85 deg. F.

Oil Pumps—3, Ingersoll-Rand, Westinghouse motor driven. Transfer oil throughout purification and storage system.

Condenser—1, Foster Wheeler, complete with air ejector. Total effective tube surface, 25,000 sq. ft., 200,000 lb. of condensate per hour—vacuum 28 in., 17,000 g.p.m. at 60 deg. F. circulating water.

Condenser—2, Foster Wheeler motor driven, vertical circulating water pumps. 12,750 gal. per min. at 60 deg. F. water.

Intake Water Screens—Chain-Belt Co., Rex type.

General Electric Co. electrical control board equipment, reactors, transformers, switches, breakers, etc.

Air Compressors—2, Worthington motor driven. Compressed air supply for control equipment.

Air Compressor—1, Fuller Co., motor driven. 150 cu. ft. per min. at 100 psi. Station main compressed air supply.

Vacuum Sweeping System—2, United States Hoffman Machinery Corp.

Rotary Pumps—2, Sterling Pump Co., Delco motor drive, for delivering heating system returns.

Heating System Blowers—Ilg Electric Ventilating Co.

Unit Heaters—Trane Co.

Rotoclone Ventilator—American Air Filter Co. for coal handling system.

Traveling Crane—1, Shaw-Box Co. Crane & Hoist Div., 75 tons with 15-ton auxiliary hook.

Remote Valve Control—Philadelphia Gear Works, Limitorque.

Piping Contract—Wm. A. Pope Co. Fabrication by Crane Co. Valves furnished by Crane Co., Edward Valve & Mfg. Co. and Manning, Maxwell & Moore, Inc.; pipe insulation, Keasbey & Mattison Co.

der, all of which permits quick starting and ruggedness of construction.

The 12,500-kw. non-condensing, high back-pressure (topping) unit is also of the impulse-reaction type, consisting of a Rateau stage followed by 10 reaction stages. All of the high pressure steam passes through the Rateau stage when carrying loads up to 10,000 kw. For higher loads up to approximately 12,700 kw., the steam by-passes the Rateau stage and enters the first stage of reaction blading. When the unit is carrying loads greater than 12,700 kw., the steam by-passes the Rateau stage and first four reaction stages and enters the fifth reaction stage. This arrangement of stages and steam control proves to be the best solution for the work this unit is to do in the new station.

The blading in both units is of a non-air hardening nickel-chrome steel which permits welding of all shroud rings to the blade tips. The shroud rings are also of non-air hardening chrome-nickel steel material. The impulse row of blades on each unit has an integral shroud and the blades are welded at the shroud in groups of two.

It is interesting to note that because of the small heat drop between throttle and exhaust of the non-condensing unit and the specific volume of the throttle steam, the total volume of steam to be handled by the throttle valve and regulating valves of this 12,500-kw. unit is about the same as a 50,000-kw. unit designed for 1250 psi. ga., 900 deg. F. at the throttle, and 200 psi. ga. at the exhaust. The volume of steam required by the non-condensing unit is also more than twice the volume required by the 25,000-kw. condensing unit. Because of the unusually large volume of

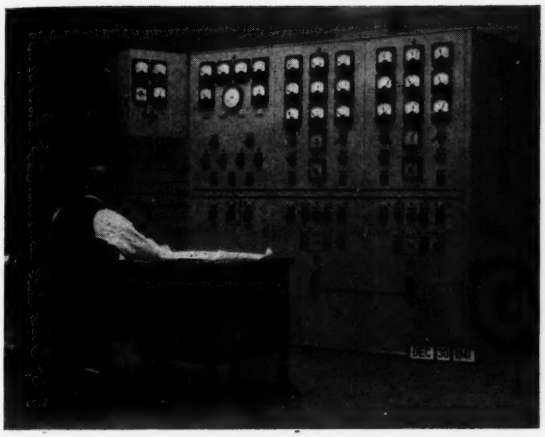


Fig. 11. Main control board for the two generators and feeder ties

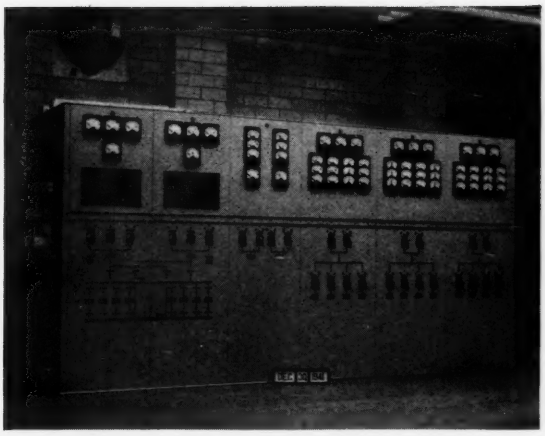


Fig. 12. Feeders and auxiliary transformer control board in main control room

steam to be handled, the unit has two steam chests placed on opposite sides of the unit with a throttle valve and three admission control valves with each steam chest.

The non-condensing unit is equipped with a back-pressure regulator to maintain constant pressure in the exhaust line that supplies the steam header of the existing condensing units. Serving the condensing turbine is a direct flow type condenser with 25,000 sq. ft. of surface consisting of Arsenical Copper tubes, expanded at both ends. Its auxiliaries include a twin-element two-stage ejector, two condensate pumps, and a pair of vertical axial flow pumps for circulating water.

Excitation for these generators is supplied by direct connected units and a supplementary exciter set consisting of a 300-kw. d.c. generator driven by either a 300-kw. steam turbine or an induction motor of 400-hp. capacity.

Lubricating oil used for the turbines is cooled in closed type coolers, two being provided for each unit. Also the generator air is cooled in units of the closed type requiring circulating water at a temperature not above 85 deg.

Current generated in this plant, except that used in the operation of the station, is delivered by means of control switches through reactors to the old plant at the generator voltage. Here it is transformed and delivered to the various substations.

This new plant has effectively reduced the overall fuel consumption per kilowatt-hour of the combined system output but an idea of what is expected from the new units may be gained from the heat balance summary of performance. For the 12,500-kw. superposed unit, the engineers calculate a heat rate per kilowatt-hour of 14,922 B.t.u. at full load, and for the 25,000-kw. condensing unit the heat rate is calculated at 12,725 B.t.u.

The Lake Road Generating Station was designed and construction supervised by Peter F. Loftus, consulting engineer of Pittsburgh, Pa., who furnished data regarding the plant, photographs and drawings used in the preparation of this article. The entire project is supervised and operated by the Department of Public Utilities of the City of Cleveland, Ohio, with J. A. Freund as Chief Engineer in charge.

PUMPS FOR MAGNESIUM REDUCTION PLANT

NEAR Boulder City, Nevada, a 63 million dollar magnesium reduction plant is now under construction for Basic Magnesium, Inc. One of the important engineering features of this plant is the novel design of six high capacity deep-well turbine pumps which will be used to provide the water needed by the plant. Each of these pumps, which were manufactured by the Peerless Pump Division of the Food Machinery Corp., is mounted on steel piers extending 200 ft. out into Lake Mead, and is capable of delivering 3800 gal. of water per minute, or a combined potential capacity of around 32 million gal. daily.

Basic Magnesium, Inc., plans to have the Boulder Dam reduction plant deliver 112 million lb. of vital metallic magnesium a year. The processed metal, stronger and lighter than aluminum, will be used in the manufacture of airplanes, ships and other weapons. The plan is to mine the ore at Gabbs and Mead, Nevada, and truck it about 200 mi. to the reduction plant, which had to be located near Boulder Dam for several reasons. The plant needs 196 thousand kw. of cheap power and 9 million gal. of water daily. The power is available only at Boulder Dam Power House and the only water source in the whole dry area is Lake Mead formed by the same dam.

Each of the six pumps is driven by a 400-hp. vertical hollow shaft motor and is capable of delivering up to 3800 g.p.m., operating under heads as high as 390 ft. Each pump calls for 200 ft. of eduction pipe, 18 in. in diameter, with a $\frac{3}{8}$-in. wall, and is equipped with a 2 15/16-in. drive shaft extending from the pump head to the impellers submerged in the lake.

To anticipate and compensate for the maximum rise and fall of the lake, these pumps are to be placed on steel piers which will extend 200 ft. from shoreline into the lake. Engineers discovered that this departure from the slower and more expensive methods will cut both time and construction costs.

Selection of the above pumps by the Basic Magnesium Corp. followed closely the installation of 30 large Hydro-Foil propellor type pumps by the Dow Chemical Co. in its magnesium plant at Houston, Tex. Individually these Dow pumps deliver up to 100,000 g.p.m. against heads of up to 60 ft. and are being used in Dow's process of extracting magnesium from sea water. This was the process that earned Dow the 1941 Chemical Award for the outstanding achievement of the year.

COAL HANDLING CHANGES CUT COSTS AND INCREASE CAPACITY

River improvement program makes available river borne coal from three additional districts. New storage and handling facilities quadruple storage capacity in same area; eliminates oxidation and spontaneous combustion; provides adequate reserve; and increases station operating efficiency 4 per cent when using all coal from storage

By PAUL WOODNORTH
Interstate Power Co., Dubuque, Iowa

IN 1930 Congress authorized the improvement, by means of locks and dams, supplemented by dredging, to provide a 9 ft. channel in the Upper Mississippi River from Minneapolis, down to the mouth of the Missouri River, a short distance above St. Louis. Navigation locks constructed are of modern design, 110 ft. wide by 600 ft. long or of ample size to lock through a tow boat with four 2250 t. capacity barges.

These improvements had progressed sufficiently so that by 1940, Upper Mississippi River transportation had increased in large volume and it was apparent that it was not only feasible but offered, particularly for bulk commodities, attractive savings in transportation costs. The Interstate Power Co., operating a 37,500-kw. steam plant located on Peosta Slough, a navigable arm of the Mississippi River at Dubuque, Ia., became interested in the savings that might be made by obtaining river borne coal and instituted a study to investigate: possible sources of coal; river location of barge loading facilities; handling facilities that would be required; the investment that would be necessary; and the savings that could be made.

It was recognized that even by supplementing receipts of river borne coal with rail shipments it would not only be necessary to increase yard coal storage capacity with the 8 mo. seasonal coal receipts by river, but it would be necessary to increase coal storage capacity as a protection to service. With the increase in fuel consumption that had occurred in the past few years, improved coal handling facilities were also required.

Additions required were decided upon, work was started early in 1941, and the first tow of three 1250 t. barges were received June 16, 1941. Prior to the installation of facilities for handling river borne coal, all coal had been received in hopper bottom cars by rail. The portion required for immediate use was dumped into a track hopper feeding a skip hoist that elevated the coal to a belt conveyor for distribution in the plant bunkers.

Coal not required for immediate use was placed in the storage yard by a locomotive crane with a 1 yd. clamshell bucket. Such coal as could not be removed from the cars by the clamshell bucket was dumped into the plant hopper after switching the cars. Coal was reclaimed from storage for use by the locomotive crane using hopper bottom cars which were switched to the plant for use. When coal was received by rail only, and handled to and from storage by the locomotive crane, it was necessary to have a number of tracks running through the storage yard for operation of the locomotive crane in storing and reclaiming.

In storing coal in this manner the following conditions were present:

1. There was excessive segregation, with the larger sizes separating and collecting at the bottom and sides of the piles. This segregation permitted air infiltration and circulation, causing oxidation and spontaneous combustion, with, at times, serious fire loss.

2. With the limited coal storage yard at Dubuque (further reduced by the space occupied by railroad tracks) the safe storage capacity without danger of firing was limited to 10,000 to 12,000 t. of coal. This was only about 1 mo. supply, and hardly sufficient protection to insure a continuous coal supply during strikes and other possible interruptions. Also full advantage could not be taken of unusual market conditions, which might make it desirable to purchase tonnage in excess of normal requirements.

3. The oxidation of the coal in storage, even for short periods and without the presence of any firing or excessive heating deteriorated the burning characteristics of the coal so that the plant capacity and efficiency when burning storage coal was somewhat reduced.

4. There was apparently no

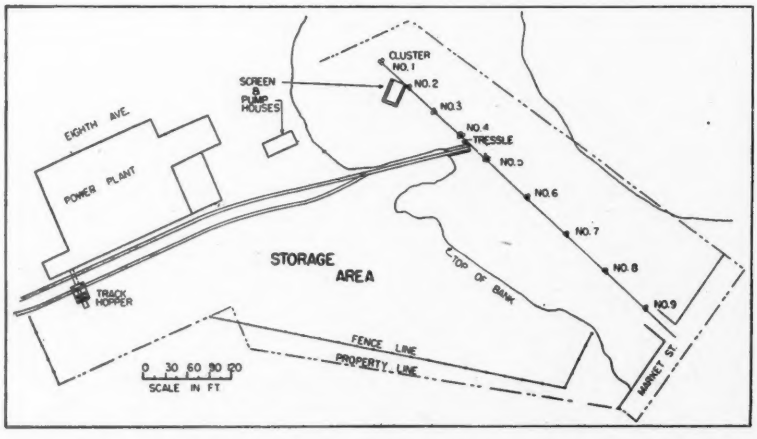


Fig. 1. Layout of the coal storage area showing the location of the power plant, tracks, hopper and dock. Each pile cluster consists of 45 ft. piles driven to El. 607.0, wrapped 12 in. below the top with four turns of ¾ in. cable with Crosby clips and stapled to the piles

Fig. 2. General view of the dock looking south down Peosta Slough toward the Mississippi and showing the wood trestle, pile clusters and cinder fill.

degradation in size with the above method of handling and storing coal. As the Dubuque steam plant uses screenings or carbon sizes exclusively in stokers and pulverized coal equipment, however, moderate degradation may be of some advantage particularly in the pulverized fuel burning units.

5. With present coal prices and freight rates, the most economical source of coal was limited to two mining districts.

With the decision to use river borne coal at Dubuque, a trestle was built extending from the coal yard into deep water in Peosta Slough. This trestle consists of a two-span standard railroad trestle and four light spans used for construction purposes. These were later filled with cinders. This trestle is at an angle to the 9 barge mooring pile clusters so that while unloading barges it is only necessary for the crane to make a 120 deg. swing. A fill was made on the south side of this trestle, on which barge coal is unloaded and the main side track which parallels, and is adjacent to, the power plant building was extended 180 ft. to the end of the trestle.

New Equipment

All other side tracks in the coal storage yard (formerly used by the locomotive crane for storing and reclaiming coal) were removed, with the exception of one track which was shifted to parallel the previously mentioned track and was connected with it at both ends of the yard.

The following equipment was purchased: 1, 80 hp. Diesel Caterpillar tractor with power takeoff; 1, Le Tourneau scraper, 8.2 cu. yd. struck, 11 cu. yd. heaped; 1, 50 t. capacity hopper bottom steel railroad car; 1, 2 cu. yd. light weight clamshell bucket; and 1, Farmall tractor with a bulldozer blade.

Provision was made to install an outdoor track hopper with a conveyor discharging to the present skip hoist loading hopper and another conveyor to discharge coal received by rail direct to yard from where it will be distributed to storage by tractor-scraper. This new hopper is of sufficient size and arranged so that the scraper can discharge coal into it either from storage or direct from the barge for plant use without crossing railroad tracks.

River borne coal is received in coal barges of 800 to 1250 t. capacity. These barges are moored to the pile clusters at the end of the trestle and are unloaded onto the cinder fill at the south side of the trestle by the locomotive crane, formerly used for handling rail coal. This crane is now using the 2 yd. capacity clamshell bucket in place of the 1 yd. bucket previously used for rail and storage coal. Normally coal is being handled at an average rate of 85 t. per hr.; with a maximum rate of over 100 t. per hr.

Bulldozer Cleans Barges

Coal in the bottom of barges is pushed into windrows by the small "Farmall" tractor bulldozer so that the clamshell bucket can pick it up in full or nearly full bucket loads. This bulldozer eliminates all hand labor in cleaning barges.

The tractor drawn scraper (which is self-loading and unloading) picks up the coal from the cinder fill taking it to the storage yard where it is discharged in thin layers. Successive trips of the tractor-scraper over the storage pile builds it up to any desired height and compacts it to increase the weight of the coal in storage from approximately 50 to 60 lb. per cu. ft. This increase in density increases the storage capacity and excludes air to prevent spontaneous combustion and surface oxidation.

During the past navigation season and due to the outdoor hopper not being in service, the 50 t. capacity car has been loaded with coal direct from barges and

Fig. 3. View from the power plant roof showing two empty 1250 t. barges, the locomotive crane and tractor scraper. The coal storage area extends into the foreground

switched to the plant for use. This car has also been used for transporting coal from storage to the plant.

With the methods and equipment now being used for handling both rail and river borne coal, we have the following improved conditions:

1. During the past summer and fall when more than three times the previous normal tonnage was stored there was only one case of heating, and this did not result in actual firing. This one case occurred on the edge or slope of a pile where the coal had not been compacted and the condition was corrected by running the tractor over the hot spot and packing the coal. No further heating was apparent, temperatures are below normal throughout the storage piles and consequently we believe that firing in storage has been completely eliminated.

2. Effective ground storage area has been increased by removal of trackage formerly used by the locomotive crane. Storage capacity has been further increased by filling the space, over the angle of repose at the sides of the coal piles as placed by the crane. Storage capacity has been increased 20 per cent per cu. ft. by compacting the coal and increasing the density. The total of these changes has increased the safe storage capacity to 45,000 t. of coal.

3. Elimination of surface oxidation of coal in storage has increased the station capacity when operating the station with 100 per cent coal from storage. This improvement has been demonstrated this winter when on a number of occasions, increased loads were carried with 100 per cent storage coal.

4. With surface oxidation eliminated, and no reduction in heating value of coal due to being in storage, there is an increase in sustained station operating efficiency of approximately 4 per cent when using storage coal.

5. We have not been able to determine any appreciable advantage or disadvantage from what slight size degradation that may occur with the river borne coal or method of handling.

6. There has been a reduction both in the delivered cost of coal and in handling expense.

7. River transportation has made coal economically available from three additional districts, giving further protection to coal supplies.

DISK VIBRATION IN TURBINE WHEELS

Critical speeds of steam turbines are directly related to disk vibration and a study of these phenomena reveals the necessity of testing each turbine wheel design to insure the elimination of disk vibration at the running speed

BY F. G. HENSEL
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De Laval Steam Turbine Co.

EARLY steam turbines with relatively small wheels and short buckets, experienced no difficulties from vibration of these parts. As capacities were increased, however, larger, thinner wheels, longer buckets and higher tip speeds were used and vibration of the wheel disk became recognized as a cause of serious fatigue or rubbing, which could result in ultimate failure of the disk or buckets. It was also found that at several critical speeds disk vibration could easily be built up to a dangerous resonance. Furthermore, at all critical wheel speeds above the lowest, the vibration reactions were so balanced that no evidence of the vibration appeared in the shaft or other parts outside the rim itself. Failure of a wheel running at one of these critical speeds, would depend upon other variable factors, such as the internal stresses in the disk, the amplitude of vibration, the tightness of the bucket fastenings, or the broadness of the resonance.

The most prominent form of vibration in a disk is a wave motion in the rim and from the principles of wave motion it follows that there are two identical wave trains moving around the rim of the disk in opposite directions. When two stones are thrown into a pond, a series of standing waves are formed where the two systems of ripples meet. Likewise, the superposition of two equal and opposite waves in the rim results in a series of standing vibrations, with stationary nodal or quiet points between them, as shown in the sketch and diagram in Fig. 2, wherein, for clarity, the wave form is shown greatly exaggerated and are the near side of the wheel only.

As may be seen, one complete wave length includes two nodes;

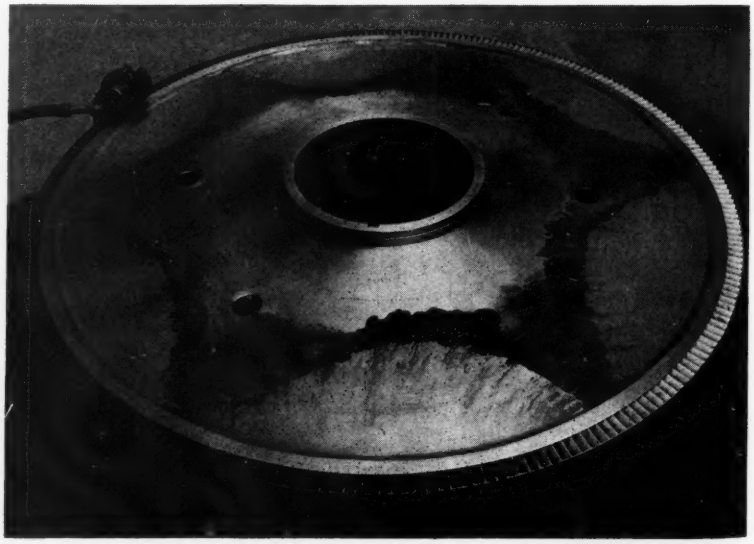

Fig. 1. Turbine wheel undergoing static disk vibration induced by a small unbalanced air turbine mounted on the rim. At critical frequencies sand sprinkled uniformly over the wheel collects at the stationary portions of nodes

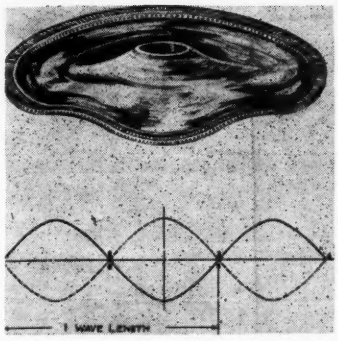

Fig. 2. Standing waves in wheel disk; shown greatly exaggerated and on front side of disk only

therefore the number of nodes is even, 2, 4, 6 or more, and for each node there is another diametrically opposite. Each nodal system, that is, each number of nodes, has its own characteristic natural frequency, the greater the number of nodes, the higher the frequency and the less easily the vibration is excited. In a two-nodal system, the two diametrically opposite deflections take place in opposite directions, thereby creating a couple on the shaft. In all other nodal systems the deflections in one direction equal those in the opposite direction and vibration cannot be detected outside the wheel itself.

Wave Motion in Rotating Wheel

In a rotating turbine wheel one of the two opposite wave trains moves forward and the other backward with respect to the rotation of the wheel and if the wheel rotates at the same speed as the backward traveling wave, this wave will stand still in space. Under these conditions the vibration is most easily excited and maintained, and this is the critical speed of the wheel for that particular nodal frequency.

When a wheel rotates at the critical speed for the 2, 4, 6 or 8 nodal vibration, the wave form may be excited by a very small force at one spot, either pulsating or steady, such as a slight inequality in steam velocity from nozzle to nozzle, due to minute variations in nozzle shape or angle. Ten-nodal or higher vibrations are less easily excited and, by reason of their smaller amplitudes, are not usually serious.

In order to be free from dangerous disk vibration in service, every turbine wheel should be so designed that its lowest critical speed is higher than the maximum running speed. In the design of De Laval turbines a systematic procedure is followed for each new turbine wheel design to insure the elimination of disk vibration, including the use of a large accumulation of experimental data, elaborate calculations of natural frequency, and measurement of the vibration characteristics of the finished wheel.

Determination of Frequencies

The various nodal frequencies can easily be measured in a stationary wheel by exciting the rim with a pulsating force of known frequency and counting the nodes formed in a layer of water or sand spread over the wheel. These nodal frequencies in a stationary wheel are referred to as "standing" frequencies. In a rotating wheel, the same nodal frequencies will ordinarily be from 10 to 20 per cent higher, due to the stiffening effect on the wheel of centrifugal force. These are called the "running" frequencies.

All De Laval wheels are designed to run below the lowest standing frequency, thereby allowing a reasonable margin of safety below the lowest running frequency which exists under operating conditions. The standing frequencies are calculated from potential and kinetic energy equations. The actual standing frequencies of the finished wheel are then measured as described above, using a small air turbine vibrator with an unbalanced wheel as the exciting force. The speed of the vibrator corresponding to each nodal frequency is read on a tachometer as the nodal patterns appear on the surface of the water film or in the sand, as the case may be, water giving the better pattern, particularly at higher frequencies. Figure 1 shows a six-nodal pattern in sand, which is more easily photographed.

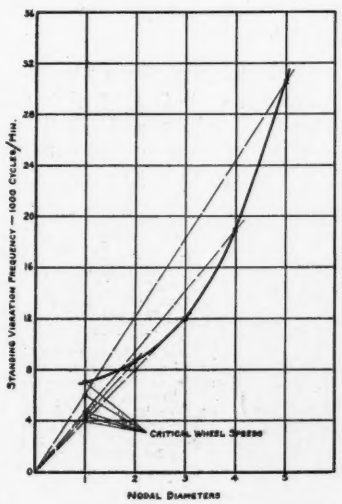

Fig. 3. A typical vibration frequency curve

When the standing frequencies for the various nodes have been measured, the corresponding critical speeds of the wheel are found from the simple relation, critical speed equals nodal frequency divided by half the number of nodes, i. e., by the number of nodal diameters. This relation may be illustrated by the following example:

Consider a stationary wheel vibrating in a standing six-nodal system at a frequency of 300 cycles per sec. The traveling waves, in making one revolution of the rim, pass through six nodes or three complete wave lengths, corresponding to three cycles. Hence the rotational speed of the wave is $300 \div 3$ or 100 revolutions per sec., which as previously shown, is the critical wheel speed.

Nodal Frequencies Plotted

A graphical method of plotting the nodal frequencies and their corresponding critical wheel speeds is shown in Fig. 3. The intersections of the radial lines with the ordinate of one-nodal diameter marks the ratios of nodal frequencies to number of nodal diameters, that is, critical wheel speeds. In this case, the third or lowest critical speed is considered the upper limit of safe running speed, and this limit of safe speed, which is based on the standing frequency for six nodes, provides a margin of 10 to 20 per cent under the running critical speed which will actually exist in operation.

Every new wheel, however slightly it may differ from previous designs, is, following final inspection, routed to the disk vibration test where it is put through a thorough vibration analysis to check its conformity to designed characteristics and to insure freedom from dangerous disk vibration in operation. Once the vibration characteristics of a particular wheel design have been established, all wheels carrying the same design symbol number may be considered as having identical characteristics, with only negligible variations.

Salt and dirt deposits on the nozzles and buckets of turbines reduce both the turbine capacity and efficiency.

Protection of boiler metal from corrosion and embrittlement necessitates a careful control of the acidity and alkalinity of the boiler water. These conditions are best indicated by determining the pH value, the meaning of which and the methods of measurement are defined and explained

Acidity and Alkalinity Measurements

By W. A. TAYLOR
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CONDITIONING of boiler water whether by external, internal or a combination of methods should result in maintaining clean evaporating surfaces in the boiler, protection against general corrosion, pitting and inter-crystalline cracking. The water must be in such a condition that the boiler will deliver an adequate supply of pure dry steam. Rate of blow down must be held at an economical figure. Boiler feedwater should be low in total solids, particularly scale formers and silica. It should be alkaline but not in too great an excess. Regulation is frequently accomplished by return of blowdown water to the feedwater. Both oxygen and carbon dioxide should be removed as far as possible.

Water in the boiler should be relatively free from hardness in all cases and in high pressure boilers hardness should be entirely absent. The water should be alkaline with a minimum pH of about 10.5. The upper limit for pH will depend on the method of treatment.

To obtain these desirable conditions of boiler water, one of the chemical problems which must be solved by the operator is the control of the acidity and alkalinity of the water. This, of course, is done by the introduction of suitable chemicals but if conditions are to be kept reasonably accurate, the operator must be provided with means for indicating the degree of acidity and alkalinity which will act as a guide to direct him in supplying the proper amount of treatment. He must know the pH value of his boiler water as it changes from hour to hour.

Titration and test papers were the methods commonly used by chemists to determine acid and alkali conditions prior to the introduction of the pH method which showed how rough and inaccurate previous methods had been. The pH method placed control of acidity and alkalinity on a definite scientific basis and enabled the chemist to express acidity and alkalinity in numerical values, which can be recorded and duplicated at any time by the same or different workers.

Meaning of Term pH

The pH scale is used to denote intensity of acidity and alkalinity. In order to make accurate determinations of intensity of acidity and alkalinity it is not necessary to know the exact scientific meaning of the term pH. The numbers 0 to 14 are used to express pH values, that is, intensity of acidity and alkalinity. The value pH 7.0, halfway between 0 and 14, is the neutral point; that is a solution having a pH of 7.0 is neither acid nor alkaline. The numbers below 7.0 denote acidity, intensity of acidity increasing as the numbers decrease. Thus a solution of pH 6.4 is very slightly acid, one of pH 4.6 is much more intensely acid. The numbers between 7.0 and 14.0 are used to denote alkalinity, the intensity of alkalinity increasing as the numbers increase. The numbers represent absolutely definite degrees of acidity and alkalinity and therefore a statement such as "acidify to pH 5.6" or "make alkaline to pH 9.4" has a very definite meaning which cannot be expressed by the terms "slightly or strongly acid or alkaline" which were commonly used prior to the adoption of pH control methods.

Change in pH represents a much larger change in intensity of acidity or alkalinity than would be expected from the pH values since a change of 1.0 pH unit represents a change of 10 in intensity of acidity. This is clearly shown in Table I in which pH 7.0 is given a value of 1.

These figures show that a material having a pH of 5.0 is 10 times as intensely acid as one having a pH of 6.0. A pH of 4.0 likewise indicates 10 times the intensity of acidity of pH 5.0. Therefore a material of pH 4.0 is 100 times as acid as one of pH 6.0. A similar relation holds for alkaline materials.

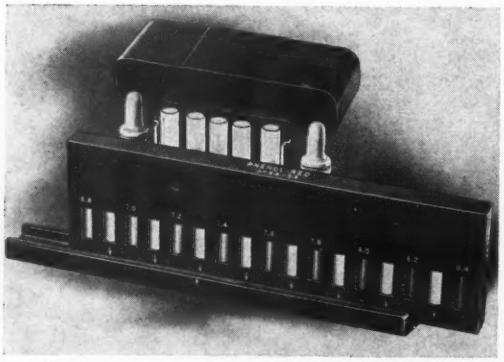

Fig. 1. Slide comparator of basic design for determining pH value of liquids

The scale is printed on the color standard slide which moves in a slot in the base at the back of which test tubes are held containing the liquid to be examined.

Titration gives total acidity or alkalinity while pH determinations give the intensity of acidity and alkalinity. The difference can be illustrated by considering the three acids hydrochloric, acetic and boric. Hydrochloric is a strong acid, acetic a much weaker acid and boric a very weak acid.

Titration of 0.1 N solutions of the three acids shows they have the same total acidity, that is the same amount of 0.1 N alkali is necessary to neutralize all of them. However, the intensity of acidity of 0.1 N solutions of these acids is roughly in the proportions 15,000 : 200 : 1. These proportions expressed as pH values are hydrochloric pH 1.0, acetic pH 2.9, boric pH 5.2.

Similarly titration of 0.1 N solutions of sodium hydroxide, sodium carbonate and sodium bicarbonate shows all three to have the same total alkalinity. However, the intensity of alkalinity is roughly in the proportions 16,667 : 667 : 1 and their pH values are 13.0, 11.6 and 8.4 respectively. These examples clearly illustrate the value of pH control and the impossibility of controlling intensity of acidity and alkalinity by titration.

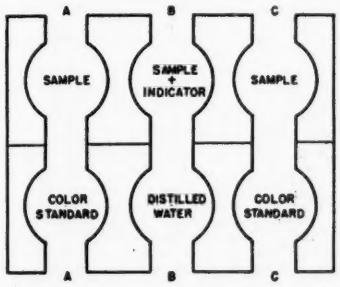

Fig. 2. Arrangement of tubes when making color comparison

Methods of Determining pH

There are two general methods for determining pH, the electrometric and the colorimetric. In the electrometric method the pH is determined by measuring with a potentiometer the voltage developed by two electrodes, both in contact with the solution. The voltage of one electrode is fixed and known (calomel half-cell); the voltage of the other varies with the pH of the sample. Three variable electrodes may be used, hydrogen, quinhydrone or glass.

The fundamental method is based on the use of the hydrogen electrode, a platinized electrode saturated with hydrogen gas. All other methods, whether electrometric or colorimetric, are secondary. While the hydrogen electrode is the standard method, it is not practical and other types of electrodes are usually used for pH control. Each has its advantages and disadvantages, but the most practical type now available is the glass electrode.

Colorimetric pH determinations are based on the assumption that when equal quantities of an indicator are added to equal quantities of solutions which have the same pH value, identical colors will be produced. While this is not strictly true it may be considered as correct for general discussion.

An indicator is a substance that gives different colors or shades of color at different pH values. Thus, phenol red changes from yellow at pH 6.8 to a deep red at pH 8.4; that is if phenol red is added to a solution having a pH of 6.8 it will give this solution a yellow color. If added to another solution of pH 7.0 it will give a somewhat redder shade of yellow. If added to other solutions having pH values of 7.2, 7.4, 7.6, etc., the amount of red color will increase progressively until at pH 8.4 the solution will have a deep red color. Therefore, if phenol red is added to any solution having a pH value between 6.8 and 8.4, the pH of that solution is determined by observing the color obtained.

Phenol red covers only a limited part of the pH scale but other indicators are available for other parts. Thus bromcresol green covers the range pH 3.8-5.4, bromthymol blue pH 6.0-7.6, etc. A complete list of indicators which cover the pH scale 0.2 to 13.6, with their pH ranges and color changes, is given in Table II.

It will be seen that some indicators have more than one useful range. Thus cresol red shows a color change from yellow at pH 7.2 to red at pH 8.8 and a second color change from red at pH 0.2 to yellow at pH 1.8. Between pH 1.8 and 7.2 there is no change, the color remaining yellow. Similarly meta cresol purple covers two ranges, pH 1.2-2.8 and pH 7.6-9.2 respectively.

In testing a material of unknown pH it is best first to make an approximate determination to show whether the material being tested is acid, alkaline or neutral. For making accurate pH determinations color standards for the various indicators are required. For example a set of bromcresol green standards consists of 9 sealed ampoules containing solutions representing the colors given by this indicator at pH 3.8, 4.0, 4.2, 4.4, 4.6, 4.8, 5.0, 5.2 and 5.4.

In all test outfits devised by the author the 9 standards alternate with ampoules of distilled water and both are contained in molded plastic slides like that shown in Fig. 1. Suppose that the approximate determination showed the pH of the material to be within the range of bromcresol green. The exact pH is determined by comparing the sample with the bromcresol green standards and reading the pH from the values on the slide.

If the materials being tested are absolutely clear and colorless accurate determinations can be made by comparing the test sample directly with the color standards, as outlined above. Most solutions encountered in actual practice are, however, somewhat turbid or colored or both. Therefore when an indicator solution is added to such a material the resulting color will not match with the color standards which contain none of the color or turbidity of the sample. For this reason some sort of comparator is required. In fact all determinations should be made with a comparator since the presence of even minute quantities of color or turbidity may cause considerable error or even make matching impossible.

Comparison with Color Standards

In making a comparison with the color standards one of the ampoules of distilled water must always be in front of the middle test tube containing the indicator, that is, one of the white arrows on the slide must be directly above the arrow on the base. Two consecutive color standards will then be directly in front of the two tubes of test sample containing no indicator. This arrangement is illustrated in Fig. 2.

AA, BB, CC represent the three slots in the base and any three corresponding slots in the color standard slide. If we consider the color

Table I. pH values and corresponding intensities of acidity and alkalinity

pH Value	Values Showing Intensity of Acidity and Alkalinity
0	10,000,000
1	1,000,000
2	100,000
3	10,000
4	1,000
5	100
6	10
7	1
8	10
9	100
10	1,000
11	10,000
12	100,000
13	1,000,000
14	10,000,000

standards as consisting of distilled water and indicator only, which is permissible since they contain no turbidity and no color except that given them by the indicator, it is clear that one is looking through exactly the same materials—sample, indicator, distilled water—in each case. This arrangement therefore eliminates any effect of color or turbidity in the sample so that, when the proper color standards are in place, the color of the sample will match one of the color standards or lie between the colors of two consecutive standards.

Table II shows that the ranges of the various indicators overlap. Thus the values pH 6.0-6.8 are common to both chlorphenol red (pH 5.2-6.8) and bromthymol blue (pH 6.0-7.6), the values pH 6.8-7.6 are common to both bromthymol blue and phenol red (pH 6.8-8.4), etc. It is therefore usually possible to make a test on any given sample with two different indicators and thus check results. Aside from the errors involved in the use of universal indicators this is another advantage in using several indicators to cover a wide pH range. On the other hand the color changes of most indicators are more pronounced near the middle of their ranges than at either end. Therefore by choosing an indicator so that the determination falls somewhere near the middle of the range more nearly accurate results are usually obtained.

Precautions to Eliminate Errors

As previously stated the hydrogen electrode is the fundamental method for pH measurements and all other methods whether electrometric of colorimetric are secondary. There is often a tendency to consider all electrometric methods such as the quinhydrone, glass and other electrodes as giving entirely accurate results also and to consider any differences between these and the colorimetric method as due to errors of the colorimetric method. Although this is far from being true there are a number of precautions which should be observed in making colorimetric pH determinations. Certain sources of error will be obvious. For example both the sample and the indicator solution should be carefully measured.

The test tubes and vessels used for taking samples should be kept scrupulously clean and glassware, samples and indicator solutions should be protected from acid or alkaline fumes and from acid or alkaline dusts such as alum, lime, etc. Pipettes should be replaced in the indicator vials immediately as they may be contaminated by laying them on the work bench.

Color standards must remain constant in shade and intensity for reasonable periods of time and they must match the colors produced by the indicator solutions in the test portion. All artificial standards such as paper, celluloid, glass, etc., must be made by matching them against liquid standards and the difficulty in doing this will be apparent. Liquid color standards are therefore the ideal ones for pH as well as for all other colorimetric determinations especially since with them one is always comparing the test sample with standards of a similar medium instead of with standards of a different material.

Readings must be made by ordinary daylight or by the use of a standard daylight outfit.

Each indicator shows definite color changes over a specific pH range which is usually about 1.6 pH units. Beyond these limits there is practically no change in color. Therefore in no case should a match with the first or last standard in any color standard slide be taken as an accurate determination. In such cases the determination should be repeated with an indicator covering a lower or higher part of the pH scale.

Temperature affects the degree of ionization of salts, acids and bases as well as of water itself and this effect may be positive, negative or negligible. Since the pH of a solution depends on the degree of ionization of its constituents, the influence of temperature on pH is an important factor irrespective of the method employed, that is whether colorimetric or electrometric. Determinations should be made at the same temperature in order to be comparable. A temperature of 25 deg. C. (77 deg. F.) is best, but for practical purposes variations between 20 and 30 deg. C. (68 to 86 deg. F.) are usually insignificant. The sulfonphthalein indicators are not influenced to any marked degree by moderate temperature changes but methyl orange and related indicators are very susceptible to such changes.

Buffer action is the property possessed by some materials to resist change in pH by the addition of acids or alkalis or by dilution. This is due to the presence of weak acids or weak bases and their salts. Examples are mixtures of acetic acid and acetates, citric acid and citrates, carbonic acid and carbonates, mixed phosphates, etc. The strength of the buffer action depends on the total concentration of the acid and salt present, the ratio of salt to acid, and other factors. Buffer strength may therefore vary from highly buffered materials to completely unbuffered materials such as distilled water.

In the power house, pH control methods have a number of applications, the most important, as previously indicated, being to the maintenance of boiler water conditions, for this purpose as well as making pH determinations to prevent corrosion by steam condensate and condenser cooling water, the indicators recommended are cresol red, phthalein red and acyl red.

Table II. Table of color indicators

Indicators	pH Range	Color Changes
Acid Cresol Red.	0.2– 1.8	Red-Yellow
Acid Meta Cresol Purple	1.2– 2.8	Red-Yellow
Benzo Yellow...	2.4– 4.0	Red-Yellow
Bromphenol Blue	3.0– 4.6	Yellow-Blue
Bromcresol Green	3.8– 5.4	Yellow-Blue
Methyl Red.....	4.4– 6.0	Red-Yellow
Chlorphenol Red.	5.2– 6.8	Yellow-Red
Bromthymol Blue	6.0– 7.6	Yellow-Blue
Phenol Red.....	6.8– 8.4	Yellow-Red
Cresol Red.....	7.2– 8.8	Yellow-Red
Meta Cresol Purple	7.6– 9.2	Yellow-Purple
Thymol Blue...	8.0– 9.6	Yellow-Blue
Phthalein Red..	8.6–10.2	Yellow-Red
Tolyl Red	10.0–11.6	Red-Yellow
Acyl Red	10.0–11.6	Red-Yellow
Parazo Orange..	11.0–12.6	Yellow-Orange
Acyl Blue.....	12.0–13.6	Red-Blue

In air conditioning systems, it is important that the humidifying water be kept in a slightly alkaline condition in order to inhibit corrosion. Such treatment also serves to remove acid gases such as sulfur dioxide. For pH determinations in this service the indicator recommended is thymol blue.

Corrosion of both galvanized and iron parts in contact with refrigerating brines is best inhibited by holding the pH of the brine at 7.5 to 8.0 and treating the brines with 100 lb. of sodium dichromate per 1000 cu. ft. for the calcium brines and 200 lb. per 1000 cu. ft. of sodium and mixed brines. The recommended indicator is phenol red. When no galvanizing is present, better protection of iron is secured at about pH 9.5 and the use of phthalein red as the indicator.

With the recognition that there are practical methods of determining pH values easily applied to industrial conditions, chemists and engineers will, no doubt, find many new uses for this scientific tool which enables close control of acid and alkali conditions.

FUEL OIL HEATERS

Three articles dealing with the selection and operation of heaters for fuel oil. Part I deals with general considerations of oil characteristics and heat requirements, Part II with practical considerations of heater selection and Part III with operation and maintenance and the effect of tube deposits

By E. G. Roberts *

FUEL OIL heaters are usually needed to prepare either heavy crude or cracked fuel oil for pumping and proper atomization by bringing the viscosity within given limits, and, to provide efficient carburetion and subsequently complete combustion. Also, important secondary functions are served by the heating of the oil, for the combustion process is accelerated by the higher oil temperatures. The speed of this reaction depends on the temperature of the substances (oil and air) as well as the degree of fineness of the globules of oil broken up from the free flowing liquid state.

Preheating the air is considered as a further useful means or aid in producing rapid combustion reaction with attendant higher efficiency. Better atomization means more effective intermixing of the oil mist with particles of air, thus securing a more combustible mixture with less excess air. The higher the proportion of inflammable mixture, the more probable the success in firing with complete burning of the combustion products. Thus high fluidity of the oil and high air temperature are necessary and desirable at the burner tip for proper combustion.

Varying the oil temperature has a direct effect on oil viscosity. Low viscosity, at a given temperature in the oil fuel gives better swirling in the swirl chamber of the mechanical atomizing burner with better spray characteristics for swift and more efficient combustion outside the burner tip. The magnitude of such viscosity changes varies considerably with the viscosity-temperature characteristics of the oils burned.

An oil with a flat viscosity curve[1] will cause less change in nozzle characteristics when the oil temperature varies than an oil having a steeper viscosity gradient. This condition applies particularly to mechanical atomization where the burners have definite burning rates for a given nozzle with a fixed orifice size. The fluctuating load on such burners requires several nozzle sets for load variations although operators attempt to make small load variations by changing the oil pressure.

A chart of viscosity versus temperature varies, depending on the properties of the fuel oil fractions or blended mixture. The viscosity-temperature relationship for fuel oils forms a family of curves of widely divergent character, as shown by Figs. 1 and 2. Thus the curve depicting the characteristic for the particular fuel oil in use should be obtained previous to making a heater selection. The relationship between Saybolt Universal viscosity readings in seconds (Sec. Saybolt Universal or SSU) and the oil temperatures in degrees Fahrenheit are best shown by curves.

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[1] This effect, as well as other points brought out later in connection with viscosity temperature charts, is well illustrated by Fig. 6, p. 59 of the October, 1940, issue of Power Plant Engineering. While that particular chart is for lubricating oils, fuel oils act similarly. Data for preparing such curves can be found in practically any text book, or for a particular oil can be obtained from the oil dealer. Differences in the slopes of the curves in Fig. 2 are not readily discernible, both because of the small scale and the fact that all the oils represented have about the same slope. With lubricating oils the slope of the curve is measured by the viscosity index, a function of the viscosity at 100 and 210 deg. F. The V. I. is described in the article referred to above in the October issue and may be calculated graphically by a chart which appeared on p. 88 of the May, 1940, issue.

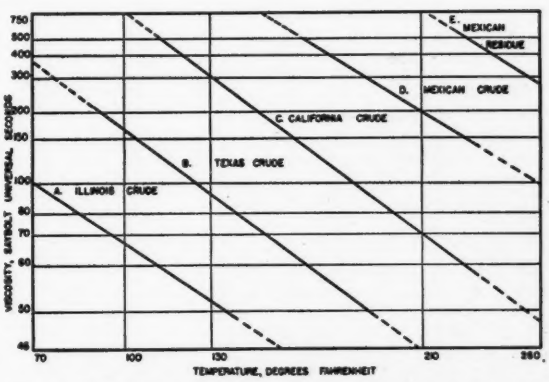


Fig. 1. (Left) Viscosity-temperature curves for five oils from different fields plotted on rectangular co-ordinates. Figure 2 is the same data plotted on special paper to show the effect of the scales used on the shape of the curve. Both of these cover about the same range of temperature and viscosity to nearly the same dimensions. While oils from a given field display somewhat similar characteristics, oils from the same geographical location, say Mexico or California, display widely divergent characteristics. The oils above should not, therefore, be considered typical of any area, but simply five samples selected at random to give good separation of the curves over the viscosity range of from about 50 to 750 sec. Saybolt Universal

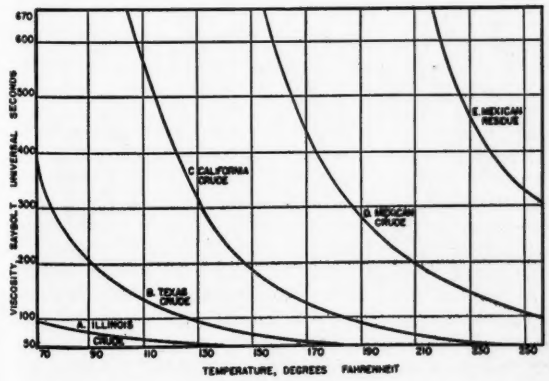


Fig. 2. (Above) The same data as in Fig. 1 plotted on special A. S. T. M. paper[2] designed to give a straight line. This is advantageous because it enables the complete curve to be determined from readings at two temperatures. It should be noted, however, that the curve is straight only in the range in which the oil is a liquid, normally the range between the initial boiling point and the cloud point. In the curves above the solid lines represent the range of actual test data, the dotted portions a continuation of the lines in order to extend the curves to the edges of the paper

Inasmuch as the relationship is logarithmic, the data when plotted on rectangular co-ordinates as in Fig. 1 shows a decided curve, Using a logarithmic scale for the viscosity values, and with an arithmetric scale for the temperatures, results in a closer approximation to a straight line. On conventional log paper, the lines are straight except in the high temperature region. To correct this a special paper[2] slightly distorted in the low viscosity region has been developed, and the data plotted on this, as in Fig. 2, results in straight lines over the liquid range.

Curves on rectangular co-ordinates, Fig. 1, are useful in indicating the temperature at which additional heating will provide very small additional reduction of viscosity: The straight line curves, Fig. 2, are useful because of the facility with which an entire curve can be determined or plotted from only two viscosity - temperature readings.

Heating the oil is accomplished by pumping it through a heater which is maintained at high temperature by medium pressure saturated steam which condenses and gives up its latent heat, or, by the use of hot water or electricity as heating agents. With steam, the usual choice, the heater element includes: tubes, straight or coiled, providing the heating surface of contact for oil; tube sheets, outer shell, headers and fixtures, depending on the layout of the heater arrangement.

Broadly speaking, heater selection requires a proper balance between the specific maximum range of operating load requirements, imposed on a given fuel oil of definite specifications, and a heat exchanger proportioned so as to maintain good heat transfer conditions continuously with low first cost and operating economy. Much of the real problem of heater selection is focused on the determination of the tube size and lengths, number of tubes per pass, overall dimensions and internal arrangement of the heater for these following given conditions: effective heating area; mean-temperature difference; and overall coefficient of heat transmission; maximum and minimum load requirements. Adequate capacity must be available for heating oil to the proper viscosity for atomization and combustion in event that a different oil of the same commercial grade is purchased.

All these factors involve the consideration of the action within the heater, i. e., pressure, temperature and velocity, viscosity and other physical characteristics, of the oil for which the Reynolds' Number serves as an index in the laminar as well as turbulent region for a heater of fixed dimensions. To avoid excessive pressure drop in the tube passages oil velocities are ordinarily kept below the critical value of Re of about 2200.

It is the primary function of the oil heater to heat the fuel oil to this optimum condition for proper atomization and combustion regardless of its specification. The process of heat transfer to the oil begins while it is a viscous fluid. As the temperature rises the oil flows more freely as shown by Fig. 3, but it is only in the last passages of the heater tubes that the flow conditions approach turbulence. In the larger tube sizes, fuel oil at 150 SSU (Seconds Saybolt Universal) can attain a turbulent flow. The necessary condition depends on pressure drop limits, and whether the critical velocity is exceeded under these limits of pressure for given tube sizes, or, if there is time enough before the oil reaches the exit.

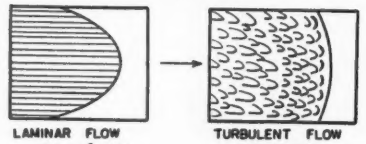
Under these circumstances the heat transfer rate in the last part of the tube passages would be very rapid. The final oil temperature would be higher. If turbulence of the oil in the tubes could be assured, the effective heating surface and consequently the heater size could be reduced, i. e., (a) smaller heater could be selected for the same services, (b) cleanings and operating inspections would be more frequent because the amount of tube fouling is sure to increase. Heavy loads of long duration and quick fluctuating loads, where heavy demands are made on the fuel oil heater, are prone to increase the carbon deposits from oil, dirt, wax, etc., all serving as insulation.

The simple construction of fuel oil heaters tube arrangements, also wide sectional baffled passages for the oil flow outside the tubes provides delivery of oil at the discharge end under very adverse flow conditions. The tube arrangements provide easy inspection and cleaning. However, it is not likely that turbulent flow can be reached in these fuel oil heaters without tremendous pressure drops, and, unless the time for oil to pass from entrance to exit is sufficient, under favorable conditions, for the oil to absorb enough heat to reach these flow conditions.

The heat transfer rates are almost entirely dependent on, and very directly with, the oil film coefficient values at the metal tube surface. The film coefficient (Fig. 4) varies directly with the oil conductivity and the oil velocity close to this boundary surface. In the latter case, the turbulent condition, in addition to increasing this oil velocity also maintains interaction between the oil particles (scrubbing action) in all layers, thus stimulating an even greater oil velocity than for laminar flow and further improving the oil conductivity between layers.

Film coefficients, also vary inversely with the tube diameter (or distance between baffles for oil flow outside tubes) and inversely with the viscosity of the oil. With heavy viscous oils the oil layers close to the tube wall receive the heat, but the speed with which these oil particles are moved from the surface of contact of the oil and metal, depends on oil velocity and flow conditions. Further the

[2] These papers, described in A. S. T. M. Standard D 341-39, are available in four types and may be obtained from the American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa.



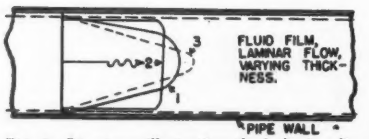


Fig. 3. Diagrams illustrating the velocity distribution within the tubes of an oil heater under different conditions. Top, for isothermal conditions in circular pipe. Bottom, distortion caused by heating and cooling. The three numbered curves are: 1, isothermal flow, (laminar). 2, fluid heated, begins turbulent flow. 3, fluid cooled, extends laminar flow

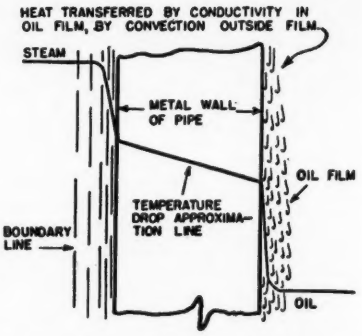


Fig. 4. Diagram illustrating the film coefficient concept of heat transfer from steam through the tube wall to oil

heavier oil particles tend to cling to the tube surface forming an insulated layer which reduce the rate of heat transfer, both because of the lowered temperature difference between the oil and metal, and, of the lowered value of film coefficients. Lighter oil particles move away faster from this boundary surface for the same given velocity. Fluid conductivity, is greater, too, because convection currents in the lighter oil take the heat into the oil layers farther away from the boundary surface.

Any action within the heater that provides increased resistance to the oil flow, increases the oil pressure drop between entrance and exit. Turbulent flow provides greater friction resistance, as does the fouling conditions which impede the oil progress by reducing the area of oil passage. Higher oil viscosities offer great frictional resistance to the oil flow. With heavy viscous oil in given tube sizes, an attempt to increase the oil velocity will create greater frictional flow resistance. To offset an extreme condition of this sort, small suction heaters are placed in fuel oil storage tanks to heat the oil and reduce the viscosity enough to facilitate oil delivery through the suction lines and strainer to the oil pump before passing on to the preheater.

Selection of a heater should take account of all these factors. It is well to obtain the viscosity temperature charts through a wide range of values for the various fuel oils that are definitely to be purchased. From these charts the various oil temperatures for proper pumping, atomization and combustion may be estimated, based on the desirable oil viscosity values for these conditions. Often the exit oil temperature is raised to 10 or 20 deg. F. higher; be sure that the oil is hot enough for proper atomization at the burner after passage through the oil discharge lines.

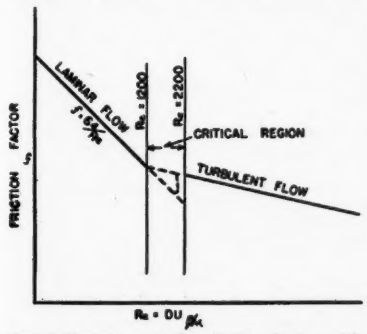


Fig. 5. Variation of the friction factor with Reynolds number for smooth circular pipes

(To be continued)

Rules for Revamping Small Plants

Part II. Case studies of three different type plants detailed before the N.D.H.A. show how the general rules stated in Part I were applied in specific cases to give: adequate steaming capacity; minimum practical first cost; provision for expansion; good firing efficiency; proper water treatment; and, adequate heating system economy

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GENERALIZATIONS involving plant rehabilitation or modernization as discussed in Part 1* covered: steam generating capacity; fuel; byproduct power generation; water conditioning; and steam for heating purposes. These generalizations as applied to three typical cases are enumerated below.

The first of these cases is a state hospital. When the study was started at this institution, the boiler plant, which contained three 600-hp. boilers had a reliable steaming capacity with one boiler down of 70,000 lb. per hr. Two boilers were 22 yr. old and one 20 yr., the remaining useful life being estimated at 8 and 10 yr. respectively. Due to an increasing demand for steam, consideration was given to changes in the existing boiler installations which would provide the necessary steaming capacity.

These proposed changes would increase the steaming capacity 21,000 lb. per hr. and would cost $45,000. Further studies indicated that a new 800-hp. boiler, with a capacity of 80,000 lb. of steam per hour could be installed in the existing space provided for the fourth boiler. Based on one boiler always being out for repairs, the reliable plant steam capacity would be increased 50 per cent or 35,000 lb. per hr. when the new boiler was out and over 100 per cent or 80,000 lb. per hr. with one of the old boilers down.

Because of a new building project, which developed suddenly, it was decided to install the new 800-hp. boiler equipped with water walls and economizer. This boiler operates at 82 per cent efficiency which is 10 per cent better than the average obtained from the old boilers. The use of this new higher efficiency boiler has provided a saving of $6,000 per yr. in coal and a reduction in maintenance cost due primarily to water walls and air cooled surfaces.

Cost of this installation, including two new boiler feed pumps, was $90,000. It not only added 80,000 lb. capacity to the plant, with a 25 to 30 yr. life, but has been a means of making the above savings in fuel and maintenance cost. Revamping the old boilers would not have given enough additional steam to heat the new buildings and also would have provided very little, if any, savings.

This instance is one where, all things considered, it was not advisable to revamp existing equipment. When the three old boilers have to be removed because of age, a reasonable plan to follow will be to replace them with two of a capacity of the new one just installed which will then give a boiler capacity more than double that of the old boilers with no more occupied space in the boiler room.

Boiler Water Conditioning and Corrosion

Large quantities of hot water are required for domestic and therapeutic purposes. This hot water, together with the boiler feedwater, is all supplied from one deaerating type heater located in the boiler plant. Wells located upon the property furnish the raw water supply for all the institution requirements. All of the well water, to be heated, is passed through green sand zeolite softeners located in the power house. This softened water, together with all condensate returned from the buildings, is fur-

* See p. 70, January issue.

nished to the deaerating heater. The table shows the conditions which existed at various points in the cycle when this study was undertaken.

Condensate Loss

The practice of mixing condensate with the domestic hot water supply thus depriving the boilers of this desirable scale-free water, is not acceptable practice. It results, among other things, in an unnecessarily high blowdown. The oxygen content of the water leaving the heater indicates that the heater was not deaerating the water properly. Thus the water leaving the heater was quite corrosive.

Because of the quality of the raw water supply, merely passing it through a sodium zeolite softener was not enough to condition it properly for steam boiler use, because of the high CO_2 content in the steam. With the other necessary conditions being present, it would cause serious corrosion in heating systems so supplied.

Oxygen content of the deaerated water was found to result in part from the return of non-condensible gases to the heater with the returned condensate. It has been corrected by returning the condensate to a vented tank above the heater, where free air is discharged before the condensate reaches the heater and by putting the heater vent condenser back into service.

Blowdown

The percentage of water blown from the boilers has also been drastically reduced. This was effected by revising the routine boiler water control methods. Prior to these studies the boiler water concentration was measured by means of an hydrometer and maintained at or below a predetermined value by continuous blowdown. A recalibration of the hydrometer, however, indicated that the true concentration was considerably less than that indicated.

This resulted in excess blowdown which in turn overloaded the heat reclaimer. Measurements indicated that the blowdown going to waste was at a temperature of about 150 deg. F. Since the technique of measuring the boiler water concentration has been changed, the temperature of the water going to waste has been reduced. It is believed that savings amounting to $1400 annually result.

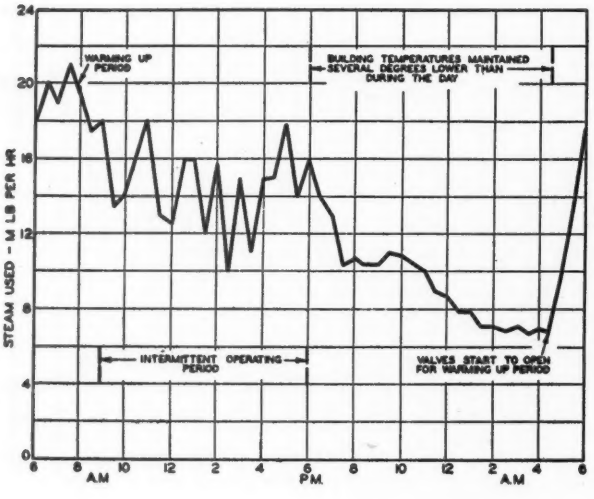
Further recommendations were concerned with an installation to permit the pumping, to the boiler, of all returned condensate so as to keep the softened make-up water at a minimum and with the installation of a boiler feedwater treating system which will eliminate the corrosive gases now entering boiler and going out from the boiler with the steam.

New buildings recently erected were equipped with automatic control, but the old buildings, which constitute more than 50 per cent of the total volume of the buildings, had no automatic control whatever. To equip these old buildings with individual room control or even zone control would be very expensive and experiments were made to determine what results could be obtained by controlling a whole building or group of buildings, this control to be based on general weather conditions taking into consideration temperature, sun, and wind.

A test was run in February in which a 12 in. valve was opened and closed at the approximate intervals at which it would be under automatic control. This test was run for 8 hr. with the outside temperature at 26 deg. F. and it was found that the valve could be kept closed about 40 per cent of the time without any complaints from the buildings being heated.

As a result of this test and experience elsewhere, three valves were ordered to control buildings where it was estimated the greatest saving could be made. These valves can be entirely automatic in operation, but also can be manually controlled, and the whole control panel is installed in the chief engineer's office so that in case of complaints he can easily make the necessary adjustments in order to raise or lower temperature as required.

On the basis of data collected elsewhere and the test made at the institution, it was estimated that this equipment will save enough coal to pay for itself in about 2 yr.



Reduction in steam use accomplished by control equipment which opens and closes building steam valves. Before this equipment was installed the load was nearly constant for the 24 hr. period

A State Normal College

This problem came up because of a building program which involved a 33 per cent increase in the building volume to be heated. Inasmuch as the existing boilers were fully loaded, additional steam generating capacity was required. The boiler capacity at this institution consisted of two 253-hp. and one 350-hp. cross drum boilers, all fired by single retort stokers. The existing peak steam load of 33,000 lb. per hr. was adequately handled by these boilers, but since the maximum output of the two 253-hp. boilers combined was less than the demand, the existing installation was considered inadequate properly to take care of the 33 per cent increase in buildings to be heated. The need of a new boiler was apparent.

In connection with the installation of this boiler a study was made to show how much could be saved by installing a boiler large enough to carry all the load most of the year and by making this boiler more efficient than the old ones. As a result of this study it was decided to install a boiler of about 460-hp. together with a single retort stoker and an economizer. This boiler, which has a steam generating capacity of 40,000 lb. per hr., has carried the entire heating load for the past season except for a few days when it was down for repairs.

The overall efficiency of this new boiler is about 80 per cent which is at least 12 per cent above what the old boilers were doing. This

Data Typifying Chemical Conditions at Key Points in the Cycle

Constituents	Raw Water (Well)	Zeolite Softened Water	Boiler Feed-water (1)	Boiler Water	Condensed Steam
Silica—SiO_2	3	3	1	9	—
Oxides—Fe_2O_3 & Al_2O_3	8	8	2	2	—
Calcium—Ca	76	3	1	6	—
Magnesium—Mg.	23	1	—	2	—
Sodium—Na	5	107	30	450	—
Bicarbonate—HCO_3	287	287	71	0	—
Carbonate—CO_3	0	0	0	24	—
Hydrate—OH	0	0	0	56	—
Sulphate—SO_4	39	39	19	300	—
Chloride—Cl	14	14	6	100	—
Total Solids (on evaporation)	313	328	72	800 (4)	—
Free CO_2	5	5	6	0	35
Oxygen	S (2)	S (2)	0.5 (3)	0	0.5
pH Value	7.5	7.6	7.4	11.6	5.2

(1) Water also used domestically.
(2) S = saturated at the prevailing temperature.
(3) Oxygen present because of inadequate venting of heater.
(4) Low solids because of excessive blowdown—i.e. about 20% of total boiler input.
NOTE: All figures, except pH, are parts per million by weight.

higher efficiency represents a $3500 annual saving in coal. The cost of this installation was $52,000. Therefore, by making the plant more efficient considerable saving was effected on an installation which of necessity would have to have been made whether savings were possible or not. The savings give 25 per cent return, before fixed charges, on the extra investment that made them possible.

This institution consists of school buildings and dormitories totalling 10,580,870 cu. ft. of which 2,625,284 cu. ft. have been constructed within the past 3 yr. Part of the other buildings are extremely old, some having been built over 80 yr. ago.

Extensive tests were made to determine how much steam could be saved if these buildings were subject to some sort of automatic control. During these tests it was found that some rooms in some of the buildings, when closed at night, reached a temperature of 90 deg. F. and most all of them reached temperatures above any reasonable requirements. The deductions from the tests indicated that with reductions in steam use at night only, and over the week-ends, at least 13 per cent of heating steam could be saved.

As a result of the data presented it was decided to install single automatic control valves for most of the buildings. These valves are controlled by thermostats subject to outside temperature and wind and are of the automatic type with program clocks so that temperatures in the buildings can be lowered automatically for predetermined times such as nights and Sundays. Figure 1 shows how the steam flow is reduced by the automatic lowering of the night temperature in the buildings.

It was found that with an addition of 33 per cent in the volume of buildings to be heated, the combination of the new boiler and heat control equipment reduced the coal required so that the 33 per cent more building volume is being heated in various months with 4 per cent to 12 per cent less coal. This is equivalent to a saving in coal of 28 to 33 per cent when the comparison is based on the same building volume and outside temperature. Of this it is estimated that the new boiler accounts for 14 to 16 per cent and heat control 14 to 17 per cent.

A Manufacturing Concern

Buildings of the company involved are scattered over a fairly large area. Steam is required for space heating during 9 mo. and for process work for the entire year. The investigation was undertaken because the owners believed that the amount of coal used and the expense of maintaining the boilers, the turbines, and the heating equipment were unreasonably high.

The boiler plant consisted of four 250-hp. Stirling type boilers fired with V type overfeed stokers. It was necessary in the wintertime to operate three of these boilers in order to produce the steam required. Tests showed the boilers were being operated at very low efficiency. In addition, stove sized coal was being burned at an added cost of 25 ct. per ton over regular stoker coal.

It was realized that considerable improvement could be made in operation of these boilers simply by cutting down excess air and using more skill in firing. However, a study showed that if two were changed so as to have materially increased furnace volume and if they were equipped with air cooled walls, single retort underfeed stokers, forced draft fans, and instruments, the two boilers, so improved, would easily carry the load that had formerly been carried by three boilers and that the saving on an investment of about $15,000 would be enough to pay for all these improvements in a little over one year.

This program was followed and in spite of considerably increased steam load during the past 6 yr., the two boilers have been able to produce the required steam up until the present heating season. For several years it was not even necessary to fire up the two older boilers for emergency use since the two revamped boilers could be kept in service from November until May.

In 6 yr. of operation prior to the present season, these two rebuilt boilers, because of more efficient operation and the ability to burn cheaper coal, produced the steam required with a coal cost of $70,000 less than would have been required under the set-up existing before modifications were made. All this was accomplished for the original investment of $15,000.

This was an instance where the boilers still had at least 14 yr. of life and where the return in savings was so great that it made it a better investment to make changes in existing boilers rather than install a new boiler as was done at the Hospital. Also, an additional boiler was not needed for capacity since the existing boilers produced all the steam required.

In the course of this study it was found that trouble was being caused by deposits on the blades of a turbine, in the steam traps, and in the building heating systems. An analysis of these deposits showed that they were identical with the suspended matter in the boiler water. It was also found from tests that the suspended solids in the boiler water was as high as 3600 p.p.m.

Obviously the boiler blowdown was far too low. The blowdown rate was increased as a result of which the suspended solids in the boiler water were reduced to about 1500 p.p.m. This has effected some relief but is not regarded as a complete answer and the installation of a lime-soda softener, to replace the present internal feedwater treatment, was recommended.

LOAD CENTER
Power Distribution Systems For Wartime Expansion

Industry's rapid wartime expansion and the need for conserving strategic materials have given added significance to the substantial time and materials savings and to the operating advantages made possible by the load center form of power distribution systems applicable to industrial plants and buildings. At a special meeting of technical editors in New York City on January 23, a group of General Electric Co. engineers, D. L. Beeman, D. E. Craig, E. M. Hunter, R. H. Kaufmann, and F. W. McChesney outlined the merits of this system. The operating advantages were also covered in a paper by Messrs. Kaufmann and Beeman before the A.I.E.E. meeting in New York the following week. By the application of this system universally, in all expansions proposed and under way for 1942, engineers estimate that upwards of 5,000,000 lb. of copper and steel, largely in cable, could be diverted to other production requirements. This article covers the important aspects of this new system

IN THE LOAD-CENTER power distribution, power is distributed directly to the production area, or load center, and is there stepped down to the voltage at which it will be used. Short secondary cables then feed the power to motors, lamps, and other power utilizing equipment. Where the total power load of a plant or building exceeds about 1000 kv-a., several small load-center unit substations are used, distributed throughout the plant each near the center of its load area. This arrangement thus does away largely with the high cost and the voltage drop incidental to long, heavy low-voltage circuits.

Other distribution systems usually employ a large substation to transform large blocks of power from high voltage, ranging from 2300 to 15,000 v., down to the voltage at which it will be used. Long, heavy, low-voltage power cables then distribute the power throughout the factory to where it is to be used.

Load-center power distribution as such is not new. It has been used very successfully for years in the utility field. However, the recent development of standard fully enclosed and protected substation equipment specially designed for installation in production areas has opened the way to more general use of this flexible, material-saving system.

Material Savings—Lower Cost

On a medium-size factory with a power demand of 3000 kv-a., using its voltage at 480 v. supplied from two utility 13,200-v. lines, it has been estimated that 7800 lb. of steel, 11,500 lb. of copper, and 1300 lb. of other materials can be saved—all vital to our war program. This means a saving of $12,000, or 21 per cent over the more complicated, outmoded systems.

Several factors combine to effect these savings. Because the low-voltage feeder runs are short, less secondary cable is needed; this results in a large saving in copper and steel. The transmission of power from a large substation to the production area by low voltage as in the old system requires many times the copper needed to supply the same amount of power by high voltage to the load-center unit substations. Since the smaller transformers of the load-center unit substation need less secondary short-circuit current, smaller feeder breakers can be used. Instead of an outdoor

Typical load-center unit substation installed on factory floor

switching station, a small, compact, metal-clad structure is used.

Shorter Installation Time

In these days of maximum production, it is often necessary for the power system to be in and working before expansions or new plants are completed. Load-center unit substations are completely built and wired in the factory so that they reach the installation site practically ready for operation. No vault or base is required for them. All that is necessary is that a few sections be bolted together and the cable connected.

Another time-saver is the simplicity with which the equipment can be ordered. From an engineering standpoint, all that is required to obtain load-center unit substations is a simple functional specification as compared to the old system which requires a complete specification for every part.

Improved Performance

Because of the shorter secondary runs, voltage variations and flicker are less than with the old system. For example, the voltage drop from the beginning of the primary line to the end of the longest secondary of the plant outlined earlier would be one-half as much for the load-center system as for the old system. Improved performance of motors and lamps consequently more and better production result.

In the event of a failure, service can be restored more quickly because less time and equipment is required to move the small units.

The old method requires accurate forecasting of the location and magnitude of the load so as to determine the best location for the large substation. It is also necessary to provide a "cushion" for future load growth. With load-center distribution the units can be placed right on the production floor where needed and units added when and where needed without disturbing the distribution system. Load-center unit substations can be moved easily from one location to another to cope with changes in electrical demands accompanying changes in manufacturing technique.

A major advantage of the load-center system is its flexibility whereby it can be tailored to fit almost any application through the use of any one or combination of four basic circuit arrangements for a given plant. Each has certain advantages and its application must be considered in the light of the particular requirements of the individual plant as regards first cost, safety both to personnel and equipment, operating simplicity, maintenance, voltage regulation, power losses, and flexibility.

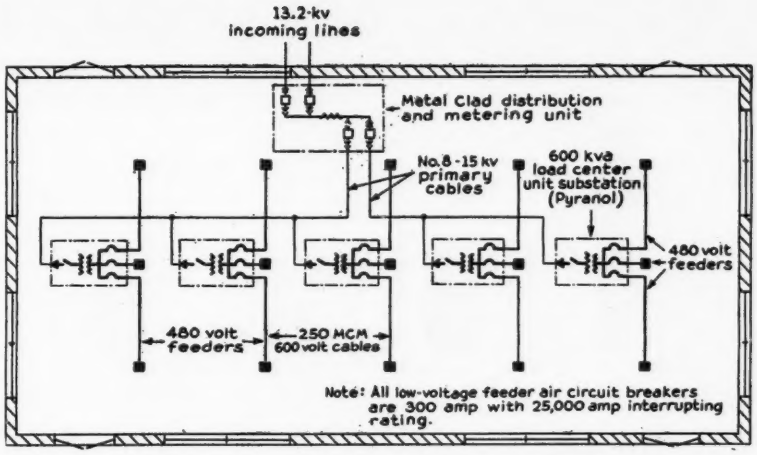

13.2-kv incoming lines
Metal Clad distribution and metering unit
No.8-15 kv primary cables
600 kva load center unit substation (Pyranol)
480 volt feeders
480 volt feeders
250 MCM 600 volt cables
Note: All low-voltage feeder air circuit breakers are 300 amp with 25,000 amp interrupting rating.

Fig. 1. Schematic wiring diagram of load-center power distribution system

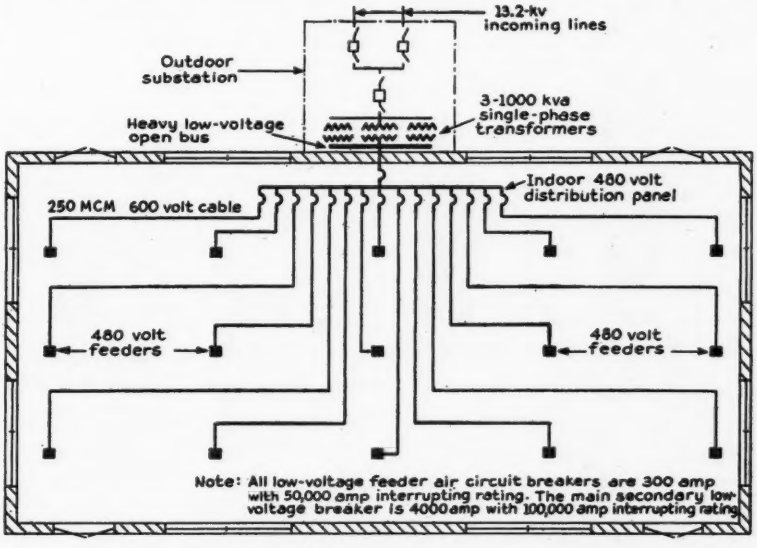

13.2-kv incoming lines
Outdoor substation
3-1000 kva single-phase transformers
Heavy low-voltage open bus
Indoor 480 volt distribution panel
250 MCM 600 volt cable
480 volt feeders
480 volt feeders
Note: All low-voltage feeder air circuit breakers are 300 amp with 50,000 amp interrupting rating. The main secondary low-voltage breaker is 4000 amp with 100,000 amp interrupting rating.

Fig. 2. Schematic wiring diagram of old style distribution system

For plants where occasional service interruptions would not be serious, such as in noncontinuous process plants, the simple radial system is satisfactory. This arrangement is the simplest, and therefore lowest in cost, of the four basic circuit arrangements since power is supplied to each low-tension load area by a single direct electrical channel.

The simplicity of this system together with its equipment for adequate interrupting capacity make it easy to operate and safe. Voltage regulation is only slightly inferior to the more expensive arrangements. Reliability is not as high as other arrangements, for a failure of the primary cable or other equipment interrupts the flow of power to the entire power block until the condition is rectified. Inspection and maintenance is also likely to demand an interruption in power flow.

Primary Selective System

The primary selective system provides for two sources of power supply, thus making available an alternate source, should a failure occur on one primary feeder. Under normal conditions the simplicity and operating characteristics of this system are practically the same as in the simple radial system.

This system makes it possible to re-establish service to all load centers with one primary feeder de-energized. Thus, the time of the outage is limited only to that

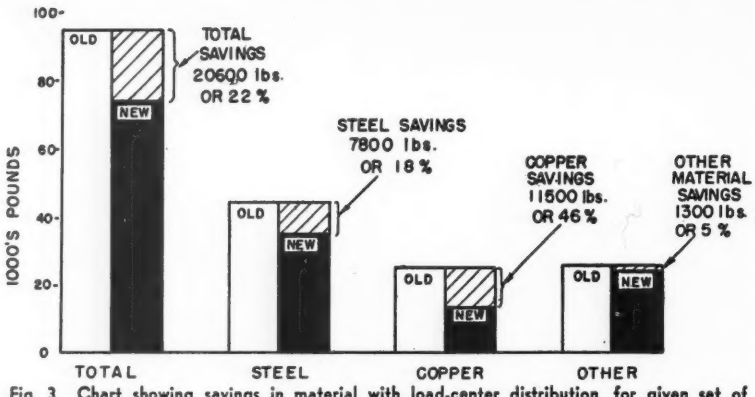


Fig. 3. Chart showing savings in material with load-center distribution, for given set of conditions

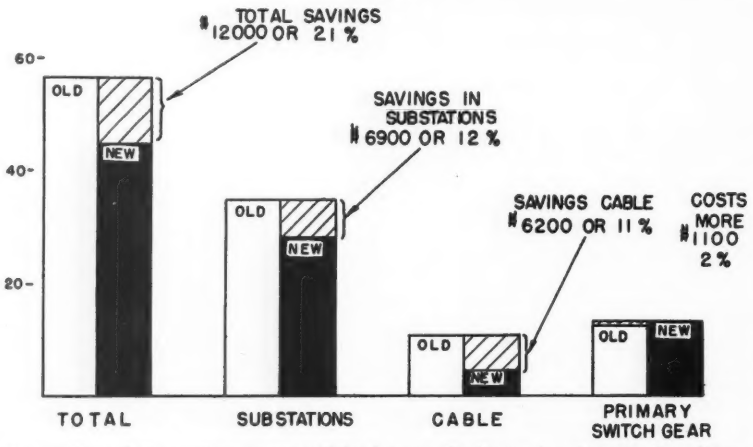


Fig. 4. Chart showing savings in cost with load-center distribution, for given set of conditions

period needed to change over to the alternate source at the respective load-center unit substations.

The maintenance and/or inspection of primary circuit equipment requires only a short interruption, since the load centers can be individually transferred before de-energizing the primary feeder.

The operation of this system under emergency conditions is somewhat complicated by the need for primary circuit switching whereas normal service switching operations are accomplished with low-tension circuit breakers.

Another disadvantage, which may be taken care of through the use of a primary loop-circuit arrangement, at added cost, is the close physical association of both primary feeder circuits at each load-center primary switching unit. Trouble at this spot as a result of electrical failure, fire, bomb explosion, etc., might involve both circuits and result in a complete loss of service.

Of the four basic circuit arrangements, the secondary selective system seems to offer the greatest promise of widespread acceptance. This arrangement differs from the first two systems in that the load center has complementary branches, each permanently associated with a particular high-tension feeder. Transfer from normal to emergency operation is accomplished by means of a low-tension tie breaker between the two complementary sections. This thus extends the duplication of supply to the load-center low-tension bus and provides for continued service with either a transformer or a primary feeder out of service.

In normal operation, the system is operated in simple radial manner with the tie breaker open and the transformer breakers closed.

Service reliability is very high. Electrical faults affecting service on one primary feeder cannot interfere with service on the other feeder.

Almost perfect service reliability can be obtained by incorporating means for operating the tie breaker electrically, thus accomplishing an automatic transfer.

With the exception of transformer routine inspection, all normal switching is performed with full capacity, low-tension air circuit breakers resulting in operating simplicity and safety under any contingency.

Secondary Network System

This system differs from the other arrangements in that it utilizes permanently interconnected load-center units by means of low-tension tie circuits. Emergency power for a particular load center is obtained from adjacent load centers which are associated with different primary feeders.

The need for added low-tension switching equipment and low-tension tie circuits results in a first cost considerably higher than that of the other arrangements.

Service reliability is of the highest order. A primary feeder or transformer unit may be de-energized with interrupting service to any load center. Electrical faults in the primary feeders or transformers are automatically removed without service interruption, except for a momentary voltage depression.

The necessity of opening several power source circuits to de-energize a particular low-tension bus somewhat impairs the degree of safety. Since this is a permanently connected system, operation is more complicated. The maintenance and adjustment of network protectors and relays require considerably more skill than do conventional air circuit breakers.

Table I. A comparison of cable and conduit requirements in the radial and load-center systems of power distribution

	Lb. Copper	Lb. Steel	Lb. Other Material	Lb. Total
Conventional Radial System				
Conduit and Rubber Cable	19,500	43,500	4,600*	67,600
V-C Interlocked-armor Cable	14,600	5,070	4,420	24,090
Savings	4,900	38,430	180	43,510
Load-center System				
Conduit, Rubber, and VCL Cable	4,560	16,150	4,190†	24,900
V-C Interlocked-armor Cable	3,420	2,015	1,920	7,075
Savings	1,140	14,135	2,270	17,825

*Includes 4030 lb. of rubber insulation. †Includes 947 lb. of rubber insulation.

Selecting the circuit arrangement to satisfy certain application requirements is largely a matter of balancing needed service reliability against installed cost. Service reliability requirements vary largely for various service conditions. Reliability will not be so important to warehouses and storerooms in most cases. General manufacturing plants operating on a piece-rate basis have observed that an electrical outage of as much as twenty minutes rarely resulted in decreased output for the day. Continuous-process industries, however, will be seriously affected by service interruption for any significant interval.

What Arrangement?

In the more exacting applications, the secondary network system may be justified, although even an allowable outage interval of two or three seconds will permit application of the secondary selective circuits with automatic transfer, at considerably less cost.

The General Electric unit substation involved in the load-center distribution system is a compact, unit assembly of a high-voltage switchgear section, step-down transformer section, and low-voltage switchgear section. It is shipped in sections ready to be installed, either indoors or, with a weatherproof housing, outdoors.

The primary switchgear sections are of standard vertical-lift metal-clad construction with easily removable power circuit breakers. There is a full complement of instruments, meters, and relays. Primary equipment may be supplied for one or more incoming lines in ratings up to 15,000 v. and 2000 kv-a. or higher. The power circuit breakers of this equipment would have interrupting ratings of from 25,000 to 500,000 kv-a. as required by the source of power supplying the substation.

Product Description

The step-down transformer sections in the unit substations have been especially designed for that application. They are three-phase units either of the noninflammable-insulating-liquid or air-cooled type. Primary and secondary leads are arranged for convenient throat connection direct to the switchgear sections. These unit substations step down the incoming high voltage of from 2300 to 13,800 v. to the utilization voltage of the plant served by the substation, which may be 120/208, 220, 440, or 550 v. The units are available as standard in ratings up to 1000 kv-a. at 120/208 or 220 v. and up to 2000 kv-a. at 440 or 600 v. Larger units can be furnished where the load requires, but even in cases of heavy load it may prove more economical to install two or more smaller units more conveniently located than the single larger one.

Secondary switchgear for the low-voltage distribution circuits is of the metal-enclosed drawout type with easily removable air circuit breakers designed for circuits of 600 v. or less, with breaker units of current ratings from 15 amp. up and interrupting ratings from 15,000 to 100,000 amp. as required. Both the high- and low-voltage switchgear sections are easily adaptable to extensions.

The drawout, easily removable breakers facilitate safe and speedy inspection and maintenance. Mechanical interlocks prevent withdrawal or insertion of the high-voltage power circuit breaker of the low-voltage air circuit breaker unless it is open. The watthour meters and the protective relays are also of the drawout type, permitting easy testing and calibration.

Cable

Approximately 75 per cent of the material saved by the load-center system is due to the reduction in cable required. A conventional radial system in an industrial building 400 by 750 ft. with a 3000 kv-a. load would require 94,000 lb. of material. This conventional radial could be replaced by a load-center system which would require only 73,000 lb. of material, a saving of about 21,000 lb. Of this saving, approximately 17,000 lb. is saved in cable while only 4000 lb. is saved in apparatus.

The materials required for both systems above were calculated using varnished-cambric interlocked armor cable. This reduces by about 2½ times the amount of material required for either system if the conventional method of wire and conduit were used.

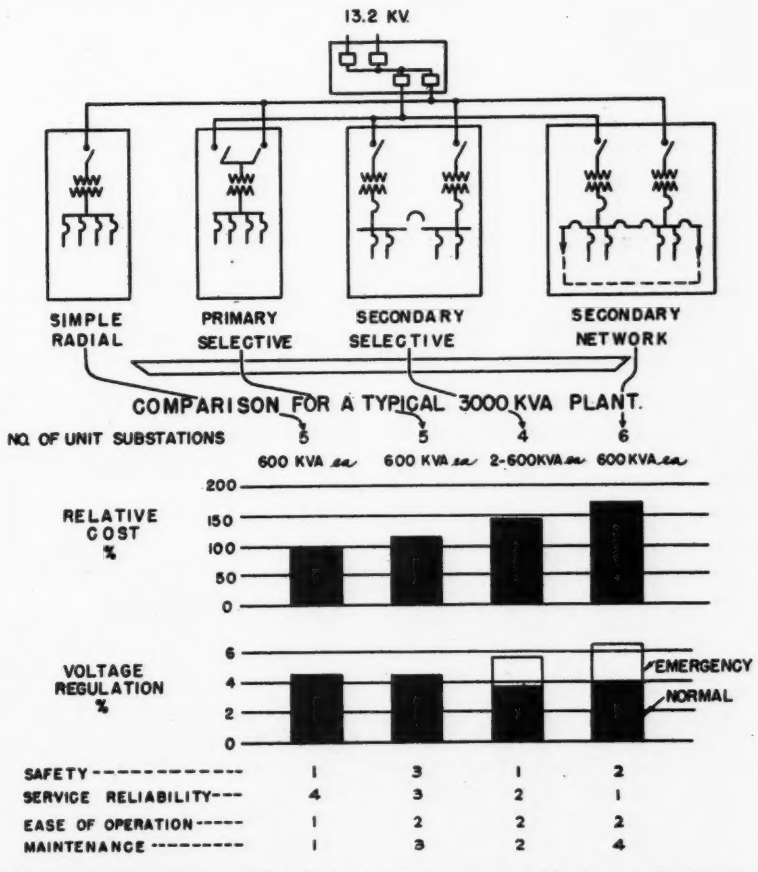


Fig. 5. Schematic diagram of four basic circuit arrangements of load-center distribution, and a comparison of them for a typical 3000 kv-a plant. At the bottom the intangible characteristics are evaluated in terms of 1, 2, 3, 4, "1" representing the best, "2" next best, etc.

Electrical Engineers' Problems Multiply in Wartime

A brief account of the technical program of the Winter Convention of the American Institute of Electrical Engineers held at New York during the week of January 26. Despite the inevitable effects of war the meeting was well attended and naturally many of the fourscore or more papers presented dealt with various aspects of war work in the electrical industry. Edison Medal presented to Dr. John B. Whitehead of Johns Hopkins University for his long work in the field of dielectric research and his many contributions to the art

By ANDREW KRAMER
Electrical Editor

IF THE CHARACTER and scope of the fourscore or more technical papers and discussions presented at the Winter Convention of the American Institute of Electrical Engineers in New York the week of January 26 constitutes any kind of a criterion by which to judge the electrical engineer's lot in general, and unquestionably it does, then it is quite obvious that the war brings the electrical engineer many strange and often intriguing forms of headaches. Concerned with countless tasks ranging from such simple expedients as making the finger ring of dial telephones of steel instead of aluminum to conserve the latter metal, to the Herculean task of augmenting the nation's installed electric generating capacity by over three million kilowatts in 1942, the war has multiplied the electrical engineer's problems enormously in every branch of the art. Incidentally, the substitution of steel for aluminum in the dial telephone finger ring saves 120,000 lb. of aluminum per year.

Much as we think of the war effort in terms of airplanes and tanks, and guns and ships, the war is fundamentally a question of horsepower. As pointed out by Philip Sporn in one of a group of papers on wartime electrical distribution systems, "this war, as in no armed clash in the history of civilized man, is a struggle between opposing horsepower."

In the vital effect this war energy is associated with internal combustion engines in armored units and airplanes and in high explosives but the energy required to make the internal combustion and explosive energy possible is largely electrical energy—the energy used in our manufacturing plants for making munitions and machines. The production of this electrical energy, its transmission, distribution, control and application is largely the electrical engineer's problem; hence the headaches.

As in former years it is very difficult, if not impossible, to give an overall picture of this annual winter meeting. In this case there were close to a hundred technical papers and many informal technical and semi-technical discussions of a great variety of interests. There were papers on control of turbine governors, on the lighting needed during blackouts, on the electric strength of Freon, on frequency modulated carrier telegraph systems, on loss-of-field protection for generators, on equivalent circuits for the hunting of electrical machines. These few subjects are representative and to understand even a quarter of the papers one would have to be a Steinmetz or Armstrong (of F-M fame) and an Edison all rolled into one.

Equivalent Circuits

The complexity of the electrical art was very well brought out at the symposium on asynchronous machinery where P. L. Alger in his characteristic manner related the story of the centipede who got along well enough until someone asked him how he knew *when* to move *which* foot and then the poor creature was so confused and mixed up he lost all control over his legs and tied himself up into an inextricable knot. The modern electrical system it seems is somewhat like the centipede, it has innumerable parts and connecting links, all of which function perfectly, normally, but let just one element get out of step for an instant and before you know it it is in the predicament of the centipede. It is for this reason that a modern electrical system has to be equipped with a nervous system, i.e. the relays, control circuits and regulating devices which coordinate the working of all the various parts.

Indeed, as was pointed out at this session, the modern electrical system has become so complex that the mathematical tools heretofore used to calculate the circuits are no longer adequate and so we have electrical calculating boards to do our calculations.

In discussing this matter with specific reference to his own paper on equivalent circuits for the hunting of electrical machinery, Gabriel Kron of General Electric briefly outlined his ultimate ambitions. All his life, he said, his goal has been to save work. His aim is to come into the office in the morning, look over his desk to see what problems there are for him, go to a calculating board, push a set of

buttons and then go out to play golf for the rest of the day while the machines do the work. Then in the evening he would stop in the office, read the answers, collect his pay check and then go home.

Admitting that he had not attained this state yet, he said that his new method of setting up equivalent circuits did enable him to play golf. Of course, it was unfortunate that some of the junior engineers had to work in the calculating board room in the meantime but it was just one of those things he had not solved yet.

Dealing with fundamental theory the discussion at this session was particularly interesting. It reflected the breadth of vision required by the electrical designer. The method of setting up equivalent circuits to represent conditions in actual machines it was shown was an expedient to enable the designer to deal effectively with a large number of involved and related conditions. As one discussion pointed out, each type of specialist likes to convert his problems into someone else's terms. Thus, the electrical engineer likes to transpose his electrical equations into a mechanical system. The mechanical engineer sets up his equations in equivalent electrical circuits. Both, of course, set up their electrical and mechanical concepts in mathematical equations and after that they both set up electrical and mechanical systems to equal their mathematical equations. It is all very mixed up but they were getting results.

It was an unusually full meeting with five solid days of technical sessions. It included the usual social activities, the smoker, the dinner-dance, the Edison Medal presentation, but because of the war, this year there were no inspection visits.

Of particular interest to those associated with heavy power systems was the session on switching equipment at which two schools of thought in regard to high capacity circuit breaker tests were aired. One school was represented by two papers describing field tests on high capacity circuit breakers—tests made on the Consolidated Edison Co. system in New York—while the other school was represented by a paper by MacNeill and Batten describing the high capacity circuit breaker testing station at the Westinghouse works at East Pittsburgh.[1]

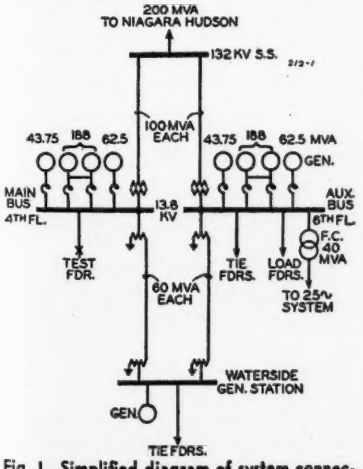


Fig. 1. Simplified diagram of system connections to Hell Gate Station in the maximum capacity tests.

Circuit Breaker Testing—Field Tests vs. Factory Tests

The field tests first described in a paper by H. D. Braley of the Consolidated Edison Co. and later in a second paper by H. E. Strang and W. F. Skeats, both of General Electric, were spectacular because of the currents and power involved. The breaker involved was a 1,500,000-kv-a., 15 kv. air blast breaker. This breaker was set up and arranged to open a three phase short circuit on the Hell Gate main bus. Hell Gate Station was selected because the greatest concentration of energy was available there with the least danger to machines or the system. Hell Gate was, of course, tied in with Waterside and other stations of the Consolidated system and the set up provided probably the greatest concentration of power ever staged. J. B. MacNeill of Westinghouse said that it probably was the maximum amount of power concentration that could be had in this country. The system connections involved in these tests are shown in Fig. 1. The tests were made at 15 kv. The highest current interrupted was 59,000 amp. and the highest current flow recorded was 111,000 amp.

Naturally it required considerable courage to stage such a series of tests on a great system supplying such a vital metropolitan area as that of New York and the most elaborate precautions were taken throughout the entire system to take care of unforeseen trouble that might arise. As a matter of fact this question of system performance under test conditions was a factor of decided importance. As was pointed out, in addition to the knowledge of the performance of the breakers which these tests provided they also furnished indications of weak points in the system which might previously have escaped detection. Indeed, several unanticipated things happened. In the first series of tests made in September, 1940 the Waterside II tie feeder was tripped at Waterside number 2 by the directional impedance relays. Later inspection of the oscillographic recording disclosed that the relay operation was undoubtedly due to asymmetry of the current, which had the effect of increasing the operating range of the relay by some 40 per cent. In another test one of the gallery observers heard a heavy static discharge, which appeared to come from the vicinity of the generator compartment. Although not directly related to the breaker tests, this condition might have resulted in an operating failure if it had not been for the observers posted in the electrical galleries.

The method of testing high capacity breakers by means of a high power test set as set forth by Westinghouse engineers, while lacking possibly the advantages accruing from knowledge of system operation, had advantages in other directions. Mr. Ludwig of Westinghouse pointed out that in the field tests the recovery voltage

[1]This test set is described on pages 79-81 of this issue.

Summary of Sessions at Winter Convention

Monday, January 26
9:00 a.m. Registration
9:30 a.m. Power Generation
9:30 a.m. Light traction
9:30 a.m. Conference on use of substitute materials in the communication industry
2:00 p.m. Power generation and transmission
2:00 p.m. Heavy traction
2:00 p.m. Conference on national defense lighting

Tuesday, January 27
9:30 a.m. Switching equipment
9:30 a.m. Auxiliary traction
9:30 a.m. Communication
9:30 a.m. Standard session and conference
2:00 p.m. System switching
2:00 p.m. Educational session and conference
2:00 p.m. Domestic and commercial applications session and conference
8:15 p.m. Smoker at the Commodore Hotel

Wednesday, January 28
10:00 a.m. General session
2:00 p.m. Symposium on distribution systems in war time
2:00 p.m. Basic sciences
Conference on what Institute Sections and members can do to help in the emergency program
8:15 p.m. Edison medal presentation

Thursday, January 29
9:30 a.m. Lightning
9:30 a.m. Symposium on asynchronous machinery
2:00 p.m. Lightning arresters and protection
2:00 p.m. Air transportation session and conference
7:00 p.m. Dinner-dance at the Waldorf-Astoria Hotel

Friday, January 30
9:30 a.m. Protective relays
9:30 a.m. Electrical machinery
9:30 a.m. Conference on arc-back in mercury-arc rectifiers
2:00 p.m. Instruments and measurements
2:00 p.m. Industrial power applications
2:00 p.m. Conference on influence of acceptance and maintenance testing on successful relay design and operation

was about 360 v. per microsecond. Their own experience had shown recovery voltages on some systems as high as 12,000 v. per microsecond. In the case of the test sets the values of recovery voltage can, of course, be controlled within wide limits.

W. S. Edsall of Allis-Chalmers in discussing these papers was surprised that the interrupting time of the air blast breakers in the field tests was so long—4½ cycles. Their own 138 kv. breakers, he said, have interrupting times of 2½ cycles. He also was surprised to find that whereas it had taken 30 yr. to develop oil circuit breakers with interrupting times of 3 cycles, it took only 2 yr. to reach 5 cycles with air blast. He felt that it would be better to admit that the principles involved in the air circuit breakers were taken from Europe where these types of breakers were first developed.

Distribution Systems in Wartime

As would be expected, the war entered into many of the technical papers in more or less degree. Of chief importance in this respect, at least insofar as their titles were concerned, was the group of papers devoted to distribution systems in wartime. Five papers were presented, all of them by members of utility companies. In the main these papers covered such elements as adequate reserve capacity, reliability of supply, conservation in the use of material and equipment, the repair of equipment after damage, etc. In some ways, however, this session was disappointing because most of the matters discussed were quite obvious and it could be assumed that any utility on the alert would have considered them.

In the discussion of these papers it was pointed out that considerably more could be done by the utilities if many of the restrictions now imposed by regulatory bodies could be removed. While such restrictions do make for more reliable service in normal times, in view of the emergency conditions prevailing, they could well be abandoned "for the duration". It was also pointed out that there was much the distribution engineer could do in the way of changing his own practices and philosophy; indeed, many of the papers dealt with this aspect of the problem. In the construction of pole lines, the use of longer spans than heretofore considered permissible would result in the conservation of poles, crossarms, hardware and insulators. These points were covered very informatively in Detroit Edison's Harold Cole's paper on overhead distribution in war time.

From a power standpoint perhaps the most interesting paper presented at the convention was the one by J. A. Krug, Chief of the Power Branch of the War Production Board, entitled, "Mobilizing Kilowatts for War". In this address, Mr. Krug outlined the power situation as seen by the War Production Board. Power, he said, was perhaps the most important of the nation's resources. At the present time, over 51 million kilowatts of effective power capacity is available for service. To this great reservoir of power we will add in 1942 about 2,200,000 kw. of steam and 1,000,000 of hydroelectric power. It is no longer a question of how much power and equipment will be needed to carry on the war effort, it is a question of making all the power we possibly can. This will not just happen. It will require most careful planning to see that every kilowatt is used to the maximum advantage.

Among other interesting things referred to by Mr. Krug was the plan to construct mobile plants on barges. It will be possible to construct on a single barge, a standard 25,000-kw. unit capable of 30,000 kw. under high power factor. These plants will have practically the same efficiency as land plants, will cost little more, and can be towed to almost every important load center in the industrial areas.

A Peace Worth Fighting For

As usual, there was a Wednesday evening meeting at which the Edison Medal presentation was made this year to Dr. John B. Whitehead, for his many years' work in the field of dielectric research. Always a high point in the Winter Convention program, this year the Edison Medal meeting was notable because of an unusually splendid address on the war by Dr. William E. Wickenden, President of The Case School of Applied Science. Dr. Wickenden's address, entitled "A Peace Worth Fighting For," was a clear and dispassionate analysis of the many and complex factors which had led to the war and an equally clear discussion of the factors that will have to be considered in establishing a permanent peace—a peace worth fighting for. As he expressed it, if the peace that is to follow this war is to be no better or different from the one that followed the last war, it would be generally agreed that such a peace would not be worth fighting for.

The conference on the use of substitute materials in the communication industry was extremely interesting and served to show how the communication engineers have met the many problems imposed on them by shortages of what were thought to be vital materials. Equipment used in communication is small compared to that used in power service, yet it was estimated that some 25,000 t. of copper will be saved annually by curtailment and the use of substitutes. Out of the 2,500,000 lb. of aluminum used each year in the communication industry, they have been able to save 2,000,000 lb.—approximately 80 per cent. In some instances the use of substitutes or alternates takes rather curious turns, for example in the substitution of copper for aluminum bus bars.

In the manufacture of tubes, in 1941 the total annual production required less than 3000 t. of metals, not a great deal compared to that needed by other industries but some of these metals are of vital importance, nickel for example. Nickel is an ideal material for tubes, it is easily fabricated, easy to de-gas, does not rust and is used as plates, grids, shells, caps, etc. Much work has been done in searching for an alternate material and in the past 5 yr. R.C.A. has made extensive investigations into the use of steel in tubes in place of nickel. For grids, the first alternate was Monel but now they use nickel plated or silver plated steel wire.

In some cases the search for a substitute leads to an entire and fundamental change in design. In the production of radio sets the use of voltage doubler power supplies saves on transformer weight and requires less packaging. In another direction investigations are under way toward the development of an electronic filter, tubes in which the grid is ripple controlled and the a.c. ironed out in the plate impedance.

These brief summaries of some of the sessions, while in no sense exhaustive, will serve to indicate the variety and scope of the program of the Winter Convention. Almost every element of the electrical art was represented. Despite the inevitable effects of the war, the attendance was good, falling only slightly below that of previous years.

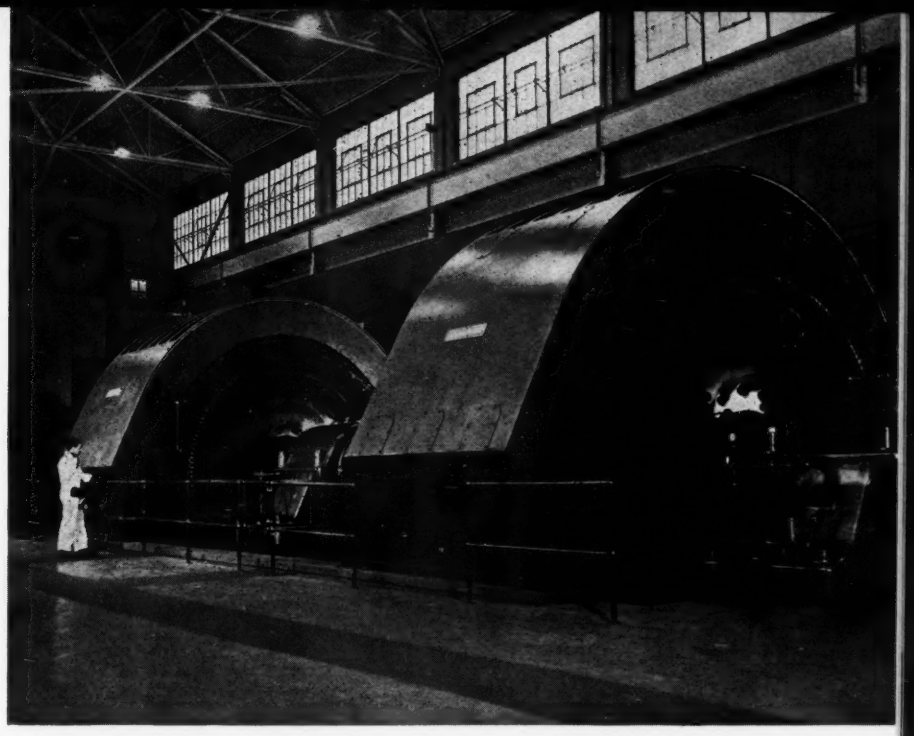


Fig. 1. Power twins. These two 60,000 kv-a generators in the Westinghouse high power testing laboratory can produce an initial three-phase symmetrical short circuit of 2,000,000 kv-a at 13.2 kv. Driven by a 6000-hp. driving motor, each unit runs at 514 r.p.m. for 60 cycle operation. Generators are synchronized electrically with provisions made for mechanical coupling if desired. Stators are spring-mounted to cushion the shock at the time of short circuit

HIGH POWER TESTING
Pushed to New Limits

By W. B. BATTEN
Westinghouse Elec. & Mfg. Co.
East Pittsburgh, Pa.

FACILITIES are now available for testing short circuits of 2,000,000 kv-a. in the new high power laboratory at the Westinghouse East Pittsburgh works. In addition, the previous current limit of 3200 amp. on a 132-kv. 3-phase circuit has been extended to 7500 amp. Test voltages have been raised from 230 kv. to 345 kv. 3-phase and from 264 to 396 kv. single phase with mid point grounded, thus amply exceeding present transmission voltages.

It is quite probable that all electrical engineers who know something of the great concentrations of energy in large metropolitan utility systems have a suppressed desire to see what a really high power short circuit looks like—at a safe distance, of course, and relieved of all responsibility. Those fortunate to be in a special group invited to East Pittsburgh by Westinghouse on January 22 had that desire fulfilled, for that was the occasion of the first public demonstration of Westinghouse's expanded high power testing laboratory in action. Though the purpose of this demonstration was to show how the test set is used to test circuit breakers, a preliminary demonstration was made to show what happens when some two million kv-a. are interrupted in open air. A horn gap, rigged up in the test yard, was shorted by a piece of iron wire. Under a potential of 138,000 v. a current of some 10,000 amp. was sent through this short to give a flash that was both tremendous and breath-taking. Twenty feet across, this waving, flaming, thundering arc swept upward and in some 3 sec. it broke. Three hundred kilowatt-hours of energy were used in those 3 sec. Later, an oil circuit breaker interrupted this same current in 3 cycles, or one-twentieth of a second. The test set which makes such a test possible is of extreme interest and of great usefulness. As described in this article, and as shown by the photographs, it consists essentially of two 60,000-kw. generators with suitable reactors and transformers for control purposes

The laboratory is in effect a power station delivering a short circuit output comparable with that on large power systems. In contrast it carries no continuous load, and a short circuit is a normal instead of an abnormal condition. The flexibility of the station permits duplicating of many voltages and currents corresponding to different services, classes, and ratings. Accurate control of service conditions and complete records of performance produce experimental data which, when properly used, result in new designs of proven performance.

Simplifies Breaker Design

Testing limitations in the past made it desirable in some cases to design circuit breakers with multiple interrupters arranged for adequate voltage distribution between them. To simplify the struc-

Fig. 2. Brains of the high power laboratory is this central control desk, so arranged that a single operator can guide all high power testing facilities. Included are the necessary indicating instruments, protecting relays, annunciators, and test jacks for checking all measuring and control circuits

ture, the need for increasing testing capacity is obvious, since the burden on an individual interrupter becomes vastly increased. Single interrupters for 2,500,000 kv-a. have recently been built and their lower energy, simplified structure, and reduced cost is indicative of a design trend in breakers.

Future Demands Are Anticipated

The laboratory is felt adequate for the future demands of American power system practice; in fact, its complete power is only necessary for the large capacities. However, it is in these large capacities that the major problems of design occur; for example, high speed interruption, high speed reclosing, and repetitive duty. These problems require continued activity, not only on existing units but especially on those newer developments now becoming active in this country, and on which a background of field experience at high power is lacking.

The laboratory is used to test many new developments at a wide range of voltages. Because of defense needs, the facilities are now determining interrupting ability of circuit breakers, resistance of porcelain insulators to power areas, performance of lighting arresters, power transformers, reactors, bus bars, high voltage capacitors, etc., during short circuit conditions.

Fig. 3. Setting up current limiting reactor switches for circuit breaker tests in the new Westinghouse high power laboratory. About 100 reactor combinations are possible by opening and closing the switches connected to the reactor behind the switchboard. Reactance can be varied from 5 ohms per phase to zero in small steps. Part of one of the 60,000 kv-a. generators is in the background

Highlighting the testing equipment in the new laboratory are two 60,000 kv-a. generator sets. These machines when operating in parallel can produce an initial three phase symmetrical short circuit of 2,200,000 kv-a. at 13.2 kv. Each of these sets consists of its generator, a 6000-hp. wound rotor driving motor and a direct connected exciter. The machines have 14 poles; hence they run at 514 r.p.m. for 60 cycle operation and 219 r.p.m. for 25 cycles. Lower frequencies may be obtained by operating with resistance in the rotor circuits.

The total weight of each machine is 550 tons, the weight being about equally divided between the stator and rotor. The rotor diameter is 12 ft. and has a peripheral speed of 22,000 ft. per min.; the inertia of each rotor is 8,500,000 lb. ft. The stators are spring mounted to cushion the shock on the foundation at the time of short circuit. Full capacity may be obtained from these generators at 7.6 and 13.2 kv. at 60 cycles and at 3.12, 5.5, 6.25, and 11 kv. at 25 cycles. The stored energy in the rotors of these sets is adequate to absorb the losses produced by short circuits, and it is unnecessary to disconnect the driving motors except in special cases where the short circuit is sustained for several seconds. This stored energy presents a problem in bringing the sets to a stop. With no braking, it takes two hours for the set to come to a standstill.

Second in importance is a transformer station that includes six 33,333 kv-a. single phase transformers. Supplied directly from the generators at 13.2 kv., the secondary of each unit consists of six 22-kv. coils. By a suitable secondary coil arrangement it is possible to connect them in series to obtain 345-kv., 3-phase with neutral grounded and 396 kv. single phase and midpoint grounded.

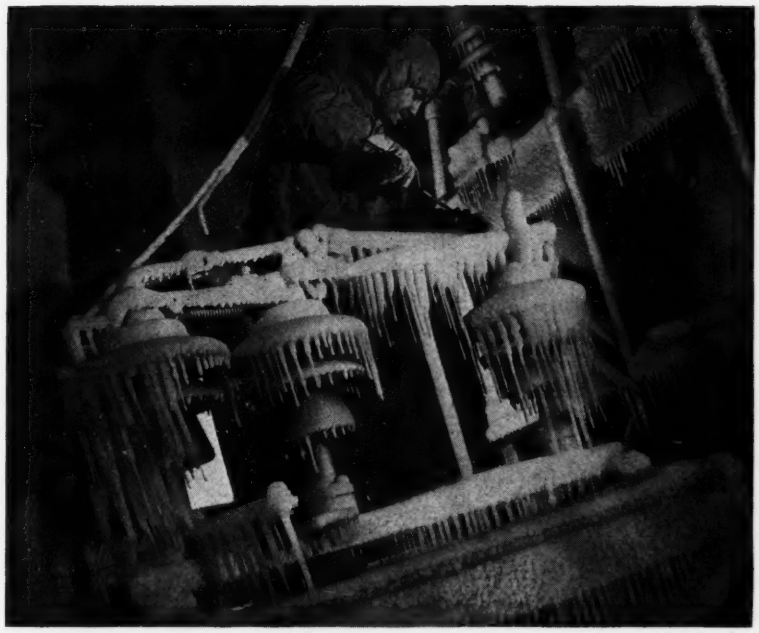


Fig. 4. Icicles form rapidly on this circuit breaker being prepared for test in the refrigerated cell of the Westinghouse high power laboratory. Refrigeration is accomplished by continually recirculating the inside air through the coils of an ammonia evaporator

Other features of the laboratory are high current transformers to provide momentary and 5 sec. current-carrying tests, a refrigerated room for testing breakers at minus 20 deg. F., and the necessary complement of control and measuring equipment.

Operation of the facilities is controlled from a central control desk separately housed about 500 ft. from the generator sets and transformers. The desk contains the necessary indicating instruments, protective relays, annunciators, and test jacks for checking all measuring and control circuits. The arrangement is such that a single operator can completely observe every test. An oscillograph records simultaneously voltages, amperes, arc energy, trip coil current, breaker travel and pressures generated in the breaker tank.

Located at key points about the laboratory and yard are safety switches. Workers in the area covered by one of these switches move to the safe position and every switch must be restored to the operating position before voltage can be applied to the generators. Protective relays and photo cells clear the circuits and de-energize the generator field in case of a power arc in the station.

A sequence drum controls the actual test operations once the voltage and current limiting reactors have been set to the desired valves. Since two sequence drums as well as two oscillographs are available, it is possible to quickly shift from one setup to another.

Fig. 5. Engineers and Executives watching the circuit breaker tests at East Pittsburgh on January 22

Performance Tests For Greases

While the desirability of purchasing greases and other lubricants by specifications, based on performance or service, has long been recognized, laboratory tests of a significant nature have been difficult to arrange. Work along this line done for the navy, however, shows considerable promise. The equipment is relatively simple and results in the laboratory for high and low temperature greases correlate well with service performance

FOR SEVERAL YEARS the Navy has known that specifications under which the purchases of lubricating greases are made are faulty and has been searching for an improved method of specification.[1] Increasing speeds, bearing loads, tooth pressures and operating temperatures have increased the demands on lubricants, in many cases beyond the point where simple composition specifications give assurance of satisfactory material.

For the lubrication of some machines and accessories, the demands of which are particularly severe, lubricants recommended by the manufacturer of the machinery have been purchased. This system of temporizing has resulted in the growth of an extensive list of proprietary lubricants, with the attendant complication of maintaining stocks of 20 or 30 special lubricants. A particularly objectionable feature has been the necessity of stocking several different lubricants for similar machines from different manufacturers.

Desirability of Performance Tests

Government Departments, particularly the Navy, have long favored the purchase of materials on a service life or work-factor basis. In the case of lubricating oils, this method has been so far developed that the work factor is applied to the manufacturer's bid price with the result that the Government instead of purchasing lubricating oil buys lubrication with oil.

Work on greases has been in progress at the Engineering Experiment Station for several years and it now appears that the specification of greases on the basis of performance instead of the former specification on the basis of composition and physical properties is possible. The work is by no means completed, but the special apparatus and the results which have been obtained to date should be of interest to producers and consumers of greases.

The object of these methods is to measure the working lubricating properties of grease without regard to the materials of which it is composed, the manner of manufacture, or its history prior to receipt. While all of these affect its properties, the evaluation of such diverse factors is impracticable. Naturally the first efforts were directed toward lubricants for apparatus in which the greatest difficulty had been encountered.

High-Temperature Grease

The first of these was the specification of lubricants for high-temperature service, in situations where grease would be exposed to temperatures of 300 deg. F. or more. An apparatus was designed and built (Navy Grease Machine 1938) in which a standard ball bearing, filled with the test lubricant, can be operated at controlled temperature and speed, while the torque is measured.

All else being equal, it is reasonable to believe that the grease with the lowest torque and therefore the lowest friction loss would be most suitable. Many precautions are necessary in order to obtain reproducibility. The first is the maintenance of a uniform filling of the test bearing with grease.

To accomplish this, a filling apparatus, called the Navy Bearing Packer, was made, with which all voids in a No. 204 open bearing can be filled. The amount of grease loaded into the test bearing by means of the bearing packer is reproducible within 1 per cent.

Principal variables affecting the torque measurements, in addition to the character of the grease, are temperature, amount and distribution of grease in the bearing, speed of rotation, and time since the start of the test. The last is important because of the thixotropy of the grease, since during working its plasticity is constantly changing.

Time can be measured, but not altered or reversed. In order to obtain reproducible results, it is necessary to collect all data in the form of torque-time curves. All other variables can be maintained constant throughout the test run.

At the start of the test run the grease is packed into 100 per cent of the voids of a weighed, No. 204, eight-ball bearing without grease shields, and the filled bearing is again weighed. The outer race of the test bearing is clamped into a brake drum and the assembly locked on the shaft of the Navy Grease Machine with the shaft through the inner race, and the brake drum connected to the torque-measuring spring.

The motor previously had been adjusted to rotate at the desired speed and the test temperature is set. The motor is started and the first excursion of the spring is read as the initial torque, with readings thereafter at first frequently, then at increasing intervals, for 1 hr. Although the torque has been observed to decline continuously, at a decreasing rate, for as long as 16 hr., the torque-time

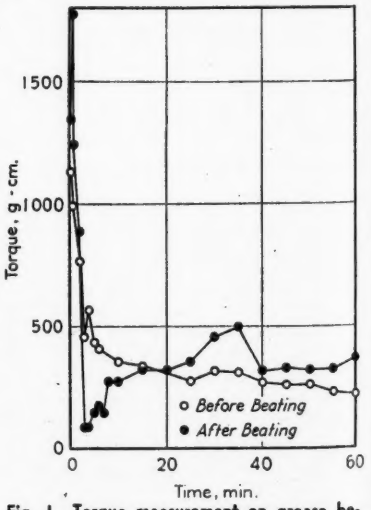


Fig. 1. Torque measurement on grease before and after high-temperature beating

[1]The tests and apparatus covered by this article were presented at the 44th Annual Meeting of the A.S.T.M. in Chicago by: Robert C. Adams, Chemical Engineer in charge of the Research Section of the Chemical Laboratory, and Harrison E. Patten, Contract Employe Engaged on Greases, of the U. S. Naval Engineering Experiment Station, Annapolis, Md. The opinions of the authors expressed at the meeting are not necessarily the official opinions of the Navy Dept. or of the Experiment Station.

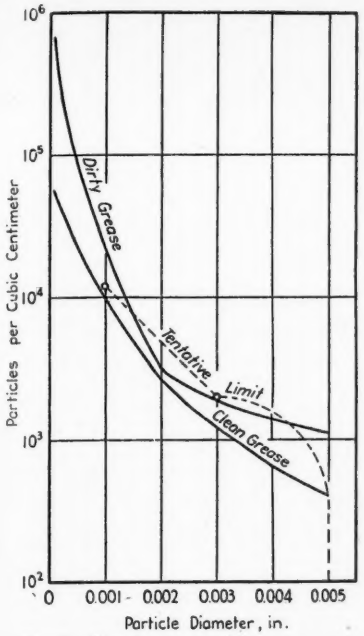


Fig. 2. Dirt in representative greases

curve obtained in 1 hr. is characteristic.

At the end of the run the bearing is removed, excess grease is wiped off the faces of the race, and the bearing weighed. The difference in weight is called leakage and is calculated to percentage of the original grease charge.

Beater Test

Deterioration of stable lubricants under high-temperature conditions is not rapid enough to be measured by tests under simulated service conditions in the Navy Grease Machine. In order to accelerate the rate of oxidation and deterioration, a high-temperature beater was devised. This apparatus consists of a single-row ball bearing, 2¾ in. O.D. with the inner race clamped by a wing nut to the lower end of the vertical shaft of a 3600 r.p.m. motor. A counterbalanced cup with electrical heaters in its jacket can be raised onto the bearing so that vertical ribs in the interior of the cup hold the outer race and prevent its rotation.

The standard high-temperature stability test consists of placing ½ lb. of grease in the cup, heating to 400 deg. F., and then beating with the rotating bearing for 7 hr. At the end of the test the residue, or grease, if it is still recognizable, can be used to fill a test bearing. Repetition of the Navy Grease Machine tests gives an indication of the extent of damage to the original properties of the lubricant. The slight increase in torque after beating indicated in Fig. 1 illustrates a grease satisfactory for high-temperature service.

On the basis of results obtained with the above apparatus, the Engineering Experiment Station has prepared a specification for high-temperature lubricants[2] which has been used for purchases of high-quality greases for almost 2 yr. The results have been entirely satisfactory.

Low-Temperature Grease

The second application of performance testing to specification of greases was to the problem of aircraft-control lubricants. Bearings in aileron and rudder hinges are in pulleys in control cable trains are exposed to ambient temperatures. This means that bearing and lubricant temperatures may vary from that of metal in tropical sunlight, about 165 deg. F., to the temperature of the substratosphere of —60 to —65 deg. F.

The original apparatus for low-temperature mobility testing consists of a vertical spindle of hard rubber with the inner race of the test bearing clamped to the lower end and a pulley on the upper end. The outer race of the test bearing is held between the two parts of a liquid-tight sleeve so that sleeve and bearing can be placed in a bath of alcohol and dry ice without wetting the lubricant in the test bearing. A predetermined torque is applied through the pulley and the time required for the initial revolution is determined. The relationship between plasticity of the grease and temperature is similar to the viscosity-temperature curve for lubricating oil.

In addition to plasticity at low temperature, a suitable lubricant must be stable at the highest temperature to which it will be exposed. There are two ways in which a grease may fail when heated; it may change from a plastic structure to a fluid and run out of the bearing (leakage), or it may separate into a stiffer plastic by losing some of the oil (bleeding).

To test for leakage, the bearing which has been used for the cold test is run in the Navy Grease Machine 1938 for 1 hr. at 150 deg. F. and 600 r.p.m. Not more than 5 per cent of the original charge should leak from the bearing during this test.

For separation or bleeding tests, 10 g. of grease are weighed into a perforated nickel filter cone which is exposed in a tared 100-ml. beaker and placed in a drying oven kept at 150 deg. F. During 50 hr. no oil or molten grease should drip into the beaker. The quantity of such leakage is determined by weighing the beaker with its separated product.

Dirt in Grease

Application of grease lubrication to high-speed precision bearings having minimum clearances makes necessary control of the non lubricant inclusions in grease. Such things as sand, uncombined lime, metal particles, hair, and vegetable fibers are present in all greases. In most applications this dirt causes no trouble; at least no casualties have been attributed to it.

It seems reasonable, however, that serious damage might be done to a ball bearing if a particle of sand having a diameter twice the clearance between balls and races were thrown into the ball track when the bearing was rotating at high speed. In order to establish standards of cleanliness a quantitative measure of dirt in grease must be possible.

The apparatus used for such measurements consists of a binocular microscope fitted with a micrometer scale in one eyepiece and a mechanical stage. The sample of grease is placed in a U-shaped template on a clean slide. The sample is then racked across the field of view while the observer counts the particles as they pass the eyepiece scale. The individual particles can be measured and their sizes recorded as they are counted.

The results of examination of two greases are illustrated in the curves of Fig. 2. Each ordinate of these curves represents the concentration of particles of the indicated size or larger which were present in the sample. Both greases were quality products of their respective manufacturers and the cleaner of the two is among the cleanest which has been examined. The absence of particles larger than 0.005 in. in diameter should be secured by adequate screening of the finished grease, but low concentrations of foreign material smaller than one or two thousandths of an inch probably can be obtained only by care in the selection of raw materials and cleanliness of equipment during manufacture. A tentative limit of foreign matter in commercially obtainable greases is indicated by the broken line in Fig. 2.

[2]Navy Department Aeronautical Specifications M-372, dated September 1, 1939; copies obtainable from Bureau of Aeronautics, Navy Dept., Washington, D. C.

War News From the Industrial Front

American Preparation for War

JUST before Pearl Harbor, the President ordered the preparation of "a report on the defense effort of the Federal Government as of December 31, 1941, . . . on the basis of factual information furnished by the various departments and agencies responsible for the program." This was completed and transmitted to the President January 14 and released January 23.

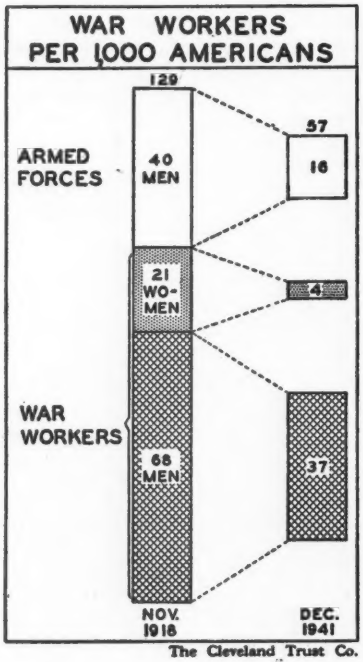
Without minimizing the enormity of the task confronting industry, nor overemphasizing the importance of steps already taken, the report outlines in chronological order the balanced preparation of all agencies to meet and defeat the enemy in every field of endeavor.

It is short (62 pp.), well written, printed in large type and should be read by every American interested in gaining an understanding of the complexities of modern warfare and the necessity of waging war on a broad front. A post card or letter addressed to Archibald MacLeish, Director, Office of Facts and Figures, Washington, D. C., will bring a copy of this "Report to the Nation".

A Long Way to Go

WHILE industrial production is at the highest point in history, the war effort is still far behind the last war from the standpoint of man power in proportion to population.

At the end of the first World War there were 2.23 American war workers for each man in the armed forces, while in December, 1941, this had already increased to 2.56, probably because industrial production was being pushed by foreign orders while the army expansion in particular was curtailed by congressional limitations on the size of the draft army.



The Cleveland Trust Co.

No Priorities for Shelters

PRIORITY assistance will not be granted for the construction of air raid shelters in the United States, it was announced by J. S. Knowlson, Director of the Division of Industry Operations, WPB, following a conference between officials of WPB and the Office of Civilian Defense.

Benefiting from British experience and the skill of American engineers, OCD has developed a design for a reinforced concrete protective shelter to hold 24 persons which uses a minimum of metal. Even this shelter, however, would require about 4750 lb. of steel for reinforcement and for a steel door. The amount of steel necessary to build enough of these shelters to protect citizens inhabiting all the coastal areas of the United States would run into fabulous amounts.

A-1-a for New Transmission Line

WPB has approved a priority rating of A-1-a for a transmission line to be built by the Ark-La Electric Cooperative from Pensacola Dam in northeast Oklahoma to an aluminum plant being built at Lake Catherine, Ark. The dam is being operated by the PWA and the aluminum plant, which will have an annual capacity of 120,000,000 lb., is being built by the Aluminum Co. of America for the Defense Plant Corp. and will be Government-owned.

In granting this priority to the Ark-La-Co-op, the WPB required that Pensacola Dam be interconnected with the private power systems at Riverton, Kan., and that the dam and all publicly-owned transmission facilities in the area be coordinated with the private power systems in the area.

Power Curtailment Cuts Peak

DURING the war period power shortages in many areas are expected to develop. Just what results can be achieved by curtailing civilian use is problematical, but in the San Francisco area peak loads have been reduced about 50,000 kw. or approximately 5 per cent by the simple expedient of turning off exposed advertising signs and floodlights, by dimming store lighting and requesting domestic users to turn off all electric signs when not in use.

Studies have also been instigated by the F. P. C. to determine the effect of daylight saving time. It is estimated that this will cut some 100,000 kw. off the annual peak in both New York and Chicago.

More Floating Power

TO MEET the need for flexibility in the power supply and bolster emergency areas the Government is planning for at least four floating power plants, mounted on barges able to navigate most inland waterways and the Great Lakes.

Each barge will be complete in itself with a standard 25,000 kw. unit, boilers, fuel tanks and auxiliaries. These plants will have practically the same efficiency as a land plant and will cost little if any more. The S. S. Jacona has rendered valuable service in the New England States and it is expected that the barges, because of the increased flexibility, will be equivalent to at least twice the capacity in a permanent location.

Sickler to Head Power Priorities

J. A. KRUG, chief of the Power Branch of the War Production Board, announced on February 5 the appointment of Barclay J. Sickler of Portland, Oregon, as chief of the priorities section of the Power Branch. Mr. Sickler is on loan from the Bonneville Power Administration, where he has been since 1939 as chief of the rate and statistics section. During the past several months Mr. Sickler has acted as a consultant for the OPM Power Branch. He will now devote full time to the WPB.

These Trifles Are Important

IT IS DIFFICULT to realize how important trifles may be in a nation of 130,000,000 people. For instance, at the request of WPB, shoe manufacturers have agreed to use japanned metal instead of brass shoe eyelets. This will save sufficient brass each year to make a million artillery shells.

Last month use of tin cans was curtailed for: baking powder; beer; biscuits; candy; cereals; chocolate; coffee; dog food; spices; and tobacco. Last year beer cans required 1600 t. of tin or more than any food except tomatoes; coffee, 900 t.; dog food, 820 t.; oil cans, 275 t.; and tobacco, 200 t. Lamps for Christmas trees, advertising, decoration and display will be eliminated and others curtailed with an expected saving this year of 110 t. of nickel; 1437 t. of brass; and 147 t. of copper.

Urges Increase in Coal Inventories

LARGE USERS of coal and coke, especially utilities and industrial users, are being urged by the WPB to build up their inventories as much as possible to avoid the danger of having to suspend operations in case of an emergency. General Inventory Order M-97, issued Feb. 13, revokes the inventory restrictions imposed by Priorities Regulation No. 1 insofar as they apply to coal and coke.

This order, issued upon recommendation of the Office of Solid Fuel Coordinator, will enable large users to take advantage of the fact that there is at present considerable excess production of coal and coke and transportation available for distribution.

Ceilings on Two Kinds of Oil

FOLLOWING refusal on January 9 to permit large oil companies to increase prices on Bunker C and No. 6 grade fuel oil at East Coast and Gulf Coast ports, the OPA on January 20 issued a schedule formally setting ceilings on those grades. The maximum prices set are those effective on January 9, f.o.b. refineries and terminals, (ex lighterage) range from $1.55 per bbl. at Albany, N. Y., to $0.85 at

(Continued on page 110)

The PRACTICAL ENGINEER and ELECTRICIAN

RICHARD H. MORRIS, EDITOR

Bagging a Sub the Modern Way

THESE DAYS it is difficult to stay away from some active phase of the war for while the industrial front is just as important it is more prosaic. Further diversion of power equipment manufacturing facilities for naval needs will intensify the engineer's problem of maintenance in order to insure maximum output with present facilities.

Then of course there is the question of sabotage which will probably be kept pretty well under cover until the end of the war. Those who minimize this danger should read The Dark Invader (Macmillan, 1933) by Captain von Rintelen. He was sent over from Germany before the United States declared war in 1917 and working through consular and diplomatic agencies was highly successful in causing labor troubles, and sabotaging industrial plants, transportation facilities and shipping.

Captured by the British on his way back to Europe he was returned to the U. S., tried in May, 1917, and sentenced to prison. As Convict No. 8891 he stayed at Atlanta Prison until 1921 when he was released and returned to Germany. The immediate cause of his downfall was Von Papen, a former diplomat in Germany's Washington embassy and now Hitler's ace diplomatic trouble shooter.

Von Papen's papers were captured by the English and the meretricious care he lavished on check book stubs told a pretty convincing story. Later this same Von Papen was surprised by Allenby's forces in Palestine and his papers captured. They wired London and the rumor is that the following cable was sent back: "Forward papers. If Papen captured do not inter. Send him to a lunatic asylum."

That, however, was during a past war, a crude one by present standards. Coming back from Washington last month I was billeted in the same Pullman section as a captain in the Army's Chemical Warfare Service and learned a great deal about recent developments and particularly of the close co-operation of the Army and Navy in developing a mysterious new green lacquer.

Barrels of this lacquer are carried by ships ready to be dumped overboard when entering submarine infested areas. The lacquer spreads over the surface of the sea in a thin tenacious film.

This film coats the submarine's periscope lens as the sub rises to get a sight. The commander, misled by the green tint, thinks he's still submerged and continues to rise. When he gets to about 500 ft. they blast him down with anti-aircraft guns. It's all much more scientific and modern than ash cans.

Richard H. Morris

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A Section of Power Plant Engineering Devoted to PLANT OPERATION AND MAINTENANCE

Technical Publishing Company
53 West Jackson Blvd., Chicago, Ill.

SO YOU WANT A NEW PLANT?

Very interesting—but just what information and data should you and the boss have before he plunks down the money? From a wide experience as operator, designer and manufacturer, the author tells the M.P.C. what he thinks "the user wants to know." Four parties, the owner, the operator, the designer and the manufacturer are involved, each with a specific problem but all with a common view point—the best plant that can be built for the money. Perhaps a simple plant with a medium to large size tea kettle is the thing for you—perhaps you need a Superdooper with all the trimmings. Maybe high temperatures and high pressures are the berries—for someone else—but don't meet your requirements at all. Finally, what type of men are going to operate this fine new plant? That's a mighty important factor

By ALFRED IDDLES, Application Engineer
Babcock & Wilcox Co., New York, N. Y.

WHEN AN OWNER undertakes to build a power station, he faces not only a problem in economics but also has need of information from all the manufacturers, the construction and the operating men. The arrangement and selection of equipment obviously should satisfy the operators provided they are willing to accept the limitations imposed by economic considerations. It should also combine the best that manufacturers have to offer. Thus there are four principal parties involved in a power project —the owner, the operator, the designer and builder, and the manufacturers of equipment. It can be assumed that the interests of all four are essentially the same and that the relationship should be one of cooperation and mutual respect.

Engineering factors are not simple and to purchase equipment as one would purchase Portland cement or wheat, has usually been found unsatisfactory. There are standardized specifications for such commodities and their purchase on a specification and test-upon-delivery basis is entirely feasible. One cannot so readily specify a boiler feed pump or an oil switch and be sure of obtaining a product which will best suit the specific requirements. The specifications must be written usually for the specific use involved and there are intangible elements of value which should be considered when comparing equipment offered.

Three Types of Information

When selecting equipment, there are three kinds of information which the owner should have, and these can be grouped under the following headings: conditions which equipment must meet; experience and ability of manufacturers who offer equipment; peculiar requirements which may be imposed by geographic location and plant operating practices.

Probably the most efficient way to produce specifications for plant equipment is to analyze the physical limitations due to the plant location, to prophesy as accurately as possible the load cycle through the probable life of the plant, and then to discuss with the various manufacturers the possibilities for meeting these conditions. The type of load, whether it be fairly constant or swinging over a wide range, may have a material effect upon boiler feed pumps and the type of prime mover to drive them. Whether a constant speed motor-driven pump or a pump with variable speed prime mover, may depend upon the amount of load variation to be expected. A discussion with the pump manufacturer would enable him to offer the best product for the purpose.

Asking for the Impossible

In writing specifications for a steam generating unit, there is a great deal more needed by the manufacturer than the plain statement of pounds of steam required per hour with pressure and temperature. Of course the most important variable probably is fuel, and, to specify that the unit shall operate with equal ease with natural gas, oil, or coal, is to ask for the impossible. The heat-absorbing characteristics are materially different for these different fuels and if uniform steam temperature is required from this same variation in load, then a very flexible and more costly unit must be designed.

To specify feedwater temperature at normal full load is insufficient. The feed temperature at the lower loads has a large effect upon superheat temperature; likewise accidental reduction in feed temperature due to heater failures has a tremendous effect upon resulting superheat and the amount of fuel to be burned. A reduction from 450 to 350 deg. F. will amount to as much as 45 deg. F. in superheat for the same steam output and means an increase of 10 per cent in the heat input. Obviously such a change will materially affect the temperatures throughout the unit and may affect the ash and slag conditions. It would be best to state clearly what the expected normal operating conditions are and then to ask for estimated results in case of departure from these standard conditions.

Higher steam temperatures have made it necessary to utilize in the superheater an increasing proportion of the total heat input and this has resulted in units more sensitive to changing conditions in the furnace. The heat-absorption capacity of the furnace walls will vary with different fuels and even will change from day to day with fuel from the same mine.

Maybe Low Temperatures Are Best

The accuracy with which either hand or automatic combustion control maintains good combustion and constant excess air will materially affect the superheater performance. In the 900 to 1000 deg. F. range, quite naturally the turbine manufacturer wishes accurate temperature control. Recently he has asked for limitations in the range of temperature and also in the rate of change in temperature. To meet these increasingly severe requirements, the steam generator must be built with a greater latitude for handling variations in conditions, particularly in cleanliness of furnaces and in excess air.

Even so, it has so far been impossible to maintain the severely constant conditions that the turbine designer would like and at the same time permit of the rapid and wide swings in steam output which some systems require. It might be well to study this situation very carefully and possibly choose less sensitive machines or more moderate temperatures for those installations where swinging loads must be carried on a single or a few turbine units.

Whether the increase in efficiency due to high superheat is warranted in view of the possible damage to the turbines or whether it justifies the extra cost of automatic control to meet the swinging load, may well be questioned. Certainly no automatic device can be expected to foresee the extent and direction of major swings in load, and if temperatures are to be maintained in a narrow range, the intelligence of supplemental hand control will undoubtedly be required. If the swings are rapid, of course even this hand control cannot keep up with changes because the response to the adjustment is not sufficiently rapid. This is inherent in equipment because of the stored heat and the large effect of relatively small changes in excess air.

It's Automatic!

Sometimes this is not appreciated by the operators. For instance, the writer observed recently a plant operating on a swinging load with steam outlet temperature varying from 925 to 1015 deg. F. Upon inquiry of the operator at the board, I was told that the automatic temperature control equipment ought to handle the situation but it was obviously inadequate because it was permitting these wide swings. This operator and probably the owner who was responsible for him should have known that a change of 10 per cent in excess air would make a change in superheat of 40 deg. F. on this unit with other conditions the same.

In this case there was a change of 20 per cent in steam output in from three to five minutes. There was heat stored in the boiler and superheater and a lag in the temperature-indicating instruments. It takes time to move dampers and readjust combustion air and no operator or owner should expect an automatic control to function under such circumstances with the accuracy which the turbine designer had asked for in this instance.

In addition to the experience of the manufacturer and the history of his past performance there is another major phase of this problem which is often overlooked. This has to do with research. By and large, it seems to be the American habit to have a large amount of research work in the power field done by the manufacturers in their plants and laboratories but because of the nature of equipment a great deal also must be done in operating plants. The willingness of the owners to purchase equipment which departs in some measure from exact past practice has often carried with it the need for patience in starting up and testing this equipment. Many times outages and loss of use occur while changes or adjustments are made.

Conflicting Needs

The third major point revolves around the operating conditions existing in a given plant. In some, the owners seem willing to purchase oversized equipment or otherwise operate at the easiest load for the equipment after its characteristics have been determined. Others expect to obtain a considerable overload from any equipment and if the specifications and negotiations do not clearly set forth the viewpoint of the owner, then the manufacturer is at a loss to know how to design.

The temptation is strong to sell that which will literally meet the requirements but sometimes these requirements are not adequately or clearly set forth and the owner then discovers that he does not have what he thought he was going to get. This ties back to the specifications and leads me to a reiteration of the fact that it is not feasible to put in writing all that should be understood in arriving at a suitable design for a specific case.

Geography and climate have a great deal to do with station design. One can do quite different things with steam units using natural gas than can be done with those burning coal in the Chicago territory. No one should expect to get ratings out of Midwestern fuel that would equal those obtainable with better coal from West Virginia and Pennsylvania. The equipment for the Midwest must, therefore, be larger and in general more expensive to produce equally satisfactory results.

After equipment has been purchased, there follows a period of detailed cooperation in which the needs of the plant designing engineer are in some measure impossible to meet by the manufacturer's design engineers. If there is any appreciable difference in the unit from those that have been constructed before, then the designing engineers wish for quick settlement of external dimensions and points of attachment to steel and piping.

This is quite contrary to the need for the manufacturer's designer to build the unit from the inside outward. It is necessary to know many of the details before the assembly drawing can be made. This is an item needing patience and active cooperation between the two parties. In fact the critical point in applying purchased equipment to an assembled plant is in the development of the drawings at this stage.

I believe the owner would like to know the amount of research that has been done by a manufacturer to enable him to produce the equipment offered; would like to feel sure that he is going to get first class workmanship by an experienced and thoughtful organization so that the minimum of delay and trouble in assembly of the entire plant will be encountered; and, above all, the owner should want to know what the equipment will not do. Neither the equipment nor its designer can control the characteristics of the coal or other fuel that is supplied.

Some of our worst recent troubles have been with slag resulting from the use of fuel oil. No designer can control the maintenance of equipment which is likely to determine the fineness of coal from the pulverizer and the perfection of combustion, nor can he regulate conditions. If the owner expects to run the units at an exceedingly high load factor and at full load or overload, then he should know whether this procedure was contemplated when the equipment was designed. A base load is much more difficult than a variable load when slag is an operating limitation.

The owner should want to know whether he has supplied his organization with sufficient trained personnel and equipment to enable it to properly care for the chemistry involved in a high pressure plant and whether the maintenance crew is competent to take care of the class of equipment being purchased. It is sometimes difficult to make a pulverized coal fireman out of an old stoker fireman. The man who could set up the brasses on a reciprocating engine may not be at all the man to handle a steam turbine. A crew accustomed to 700 deg. steam may not realize the limitations surrounding 900 and 950 deg.

"Shake hands with Mr. Mandalson, our Electrical Engineer."

FOR THE PLANT ELECTRICIAN

Planning for Fluorescent Lighting Maintenance

By E. W. BEGGS
Westinghouse Lamp Div.
Bloomfield, New Jersey

When to remove a lamp; choice of size and type; fixtures; individual vs. group replacement; lamp life and mortality rates; when to use ladders, movable platforms, catwalks, cranes or lowering hangers for replacements. If good lighting costs are to be kept low easy, regular maintenance must be assured

ALTHOUGH fluorescent lamps have an extremely long average life, nevertheless, they eventually wear out, burn out, or, fail in service. When this time comes the old lamp must be replaced by a new one so the fixtures should be so designed that lamps can be easily replaced and, equally important, the location of the fixtures should be chosen to provide ready access for maintenance.

It is impossible to predict when each individual lamp will burn out, but it is quite possible to predict the number of lamps that will fail in any given group of lamps used over a definite period of time, if the conditions are known and if the group is quite large. Lamp life expectancy curves which are similar to actuarial data for humans are used, and with them a maintenance program can be developed that will provide the maximum satisfaction at the minimum cost.

In developing such a program the lamp life expectancy should be divided into two parts. The first part is an analysis of the group of lamps installed when the fixtures were first put into operation, and the second part is an analysis of subsequent lampings.

Since the initial lamps are all new, few, if any, fail during the first few hundred hours of service. As the group of lamps ages, however, an increasing number will burn out with the rate of mortality greatest at or near the average life point. A few will remain in service for considerable longer periods of time. With the average run of fluorescent lamps, however, there is a fairly wide spread in life, and about half of the first lamping will fail in a period equal to about one-third the average life of the lamps.

The mortality curve follows the life cycle of the first or initial lamping only. The approximate number of lamps per month (or per year) that will need to be replaced after the replacement curve levels out can be estimated from the formula

$$\text{Number of failures} = \frac{\text{Hours Burned} \times \text{No. of Outlets}}{\text{Rated Lamp Life}}$$

This is the formula that should ordinarily be used although deviation from this average replacement rate must be expected during the first few lampings.

Principal maintenance requirements for economical and dependable lighting are:

1. Provide means for access to the fixture for cleaning and relamping.
2. Use fixtures designed to provide for ready cleaning and relamping.
3. Provide in advance for the replacement of lamps that are to burn out. In this, it is generally best to consider first the replacement of the initial group of lamps and then to plan for the ultimate, less erratic, replacement rate of later groups of lamps.
4. Consider the relamping and maintenance requirements of the installation when choosing the size and type of lamp to use.
5. Where a fixture or group of fixtures is extremely difficult to service, use the group replacement plan.

The more common devices now in use to reach a lighting fixture are: ladder, movable platform, and lowering hanger, and the choice of which to use is not always easy. Conditions will largely determine the best solution,

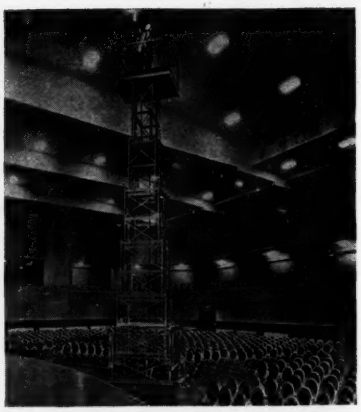


Fig. 3. A difficult problem was solved in this theatre by using this automatic telescoping tower. For heights up to about 20 ft. a simpler type of lift can be used

but in theory a decision can be reached on the basis of cost computations. This is done by first establishing the labor cost of a single relamping with each device and then, based on the number of lamp renewals needed per year, determining the overhead cost of the equipment per renewal. The most economical is, of course, the one which shows the lowest combined cost of renewal labor plus overhead.

In general, it will be found that each device has an important place in the picture. Ordinarily, where very large numbers of units are to be serviced, the movable platform is the cheapest. Where there are a medium number of units, a ladder is least expensive. Where there are only a few, the lowering hanger is the most economical. However, where a movable platform cannot conveniently be moved about on the floor to bring the maintenance man to the fixture or where the design of the building makes the use of a ladder impracticable, the lowering hanger is not only the best but is often the only solution.

Fluorescent lighting equipment can occasionally be serviced from a catwalk designed especially for the purpose or, if the layout is carefully planned beforehand, they may be serviced from a truss or modified truss paralleling the fixture. Such a system would be unusual but, where possible, should be provided. Servicing of fluor-

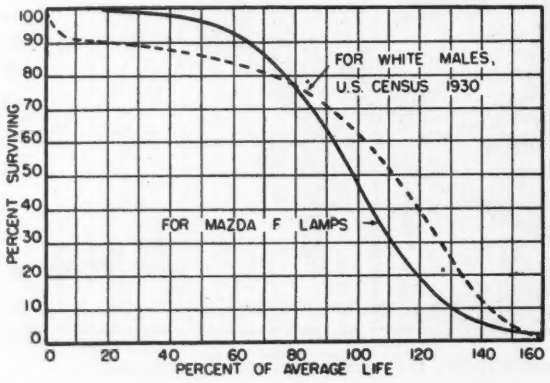


Fig. 1. (Left) The mortality curve for lamps approximates the mortality curve for human beings

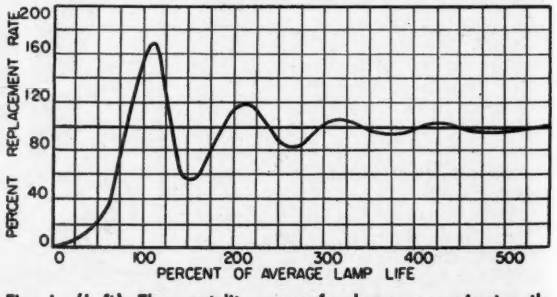


Fig. 2. (Above) Theoretical replacement rate for Mazda F Lamps based on the mortality curve of Fig. 1.

escent lighting fixtures from a traveling crane requires a suitable safe operating platform which should be provided when the crane is installed.

Consider a defense plant with 10,000 40-w. lamps burning 20 hr. a da., 25 da. a month throughout the year. The relamping problems here are startling. Substituting in the formula and computing the average number of replacements ultimately to be required, that is, 10,000 times 500 times 12 divided by 2500 equals 24,000 lamps to be replaced per year, or 2000 lamps per month after the first few relampings. That would be a sizable maintenance job, but the ultimate average replacement rate of 2000 per month is only about half of the peak replacement rate that occurs at approximately 2500 hr. and again at approximately 5000 hr.

The replacement curve reaches a peak of almost twice the average replacement rate after the lamps have burned about 2500 hr. This means that whereas 2000 per mo. or about 80 lamps per da. would be relamped after the replacement curve levels out, over 130 lamps per day would need to be replaced during the first peak period which, in this instance, would occur at about the fifth month.

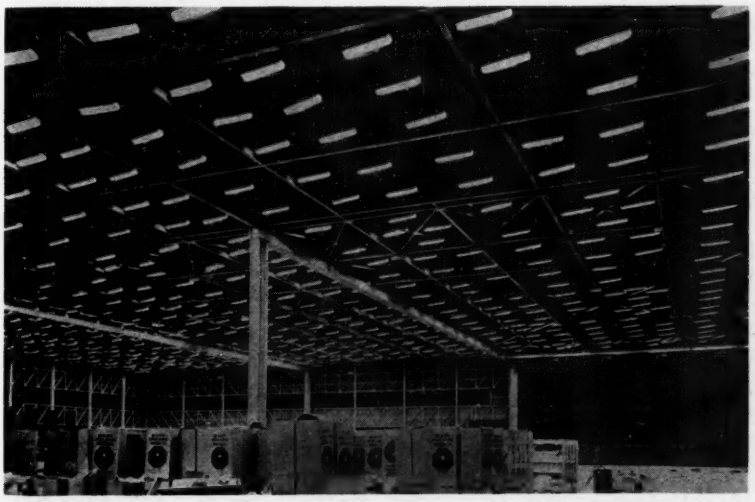


Fig. 4. The hundreds of lamps in this airplane factory are serviced by lowering individual fixtures to the floor

It is obvious that in installations involving large numbers of lamps such as are now being installed particularly in some of our new defense plants, the maintenance engineer must anticipate not only the average renewal rate but must lay his plans to handle the peak load when it comes.

It should be noted that the fluorescent lamp blinks on and off when it reaches the normal end of life. This blinking is caused by the high voltage that develops in the lamp when the emission material is worn away from both of its electrodes. This high voltage causes the glow switch, normally used, to switch the lamp alternately on and off.

Blinking should not be permitted to continue for more than an hour or so or the starters will be destroyed and perhaps the ballast will be overheated and damaged. This means that all of the above requirements, ready access to the fixture, proper fixture design for quick relamping and maintenance planning are especially important; otherwise, the switch damage and possible ballast damage will represent extra operating cost of the lighting system.

Special cutout devices are now available to prevent the blinking from continuing beyond the danger point. The 85-w., Type RF, lamp now requires no starter. Therefore, in certain instances this becomes an advantage from the maintenance standpoint of sufficient importance to be considered in planning the lighting installation.

Naturally, the fewer the lamps used and the longer the lamp life, the less will be the lamp replacement problem. This would lead to the use of larger sizes of fluorescent lamps to reduce relamping cost. The 85-w. lamp has a 3000 hr. life and requires no starter so it is especially well suited for installations where relamping is difficult. The 100-w. lamp with its high output reduces the total number of units required for a given lighting job and is also well suited to large installations where lamp maintenance will represent a serious problem.

Fluorescent lamps have, on occasion, been installed in fixtures with which relamping is extremely difficult and expensive. Some of the early fixtures, for example, required special tools and had to be partially dismantled in order to remove burned-out lamps and install the new ones. Also, some fixtures are located where access is difficult and where it is extremely costly to relamp and maintain the fixture. In such cases, group replacement, familiar to most lighting engineers in connection with incandescent lamps, should be used.

In practice, the simplest method is to replace all the lamps in the fixture or group of fixtures each time access is obtained. Those lamps which are not burned out may be used, if necessary, in other more accessible fixtures.

Group replacement may also be found to reduce the overall lighting cost if applied to an entire lighting system where access to the fixture is an appreciable cost item or where it is vital that a minimum number of lamps be inoperative at any one time. Operating under such a plan, a maintenance engineer would anticipate the approximate time of maximum replacement.

Such a time could be estimated from the discussion above particularly with the replacement rate curve in Fig. 2. For good results, the lamps should be replaced shortly before the period of peak mortality or peak replacement. In this case, the lamps that are removed before failure, can be used elsewhere or destroyed, depending upon conditions.

SHORTS FOR SAFETY

Failure of cooling water in a refrigerating condenser is serious for it causes an increase in pressure. It is important that proper high pressure cut outs and relief valves be installed and kept in good working order. It is also up to the operator to watch and heed the readings of temperature and pressure indicating instruments.

* * *

Any pressure vessel holding volatile fluids, and which can be isolated by means of a stop valve, should be protected by an independent relief valve. If stop valves are considered necessary between the vessel and relief valve, say to allow repair or inspection for leakage, the stop valves should be locked and sealed in the open position before the vessel is placed in regular operation.

* * *

Principal causes of compressor valve breakage are: operation at excessive speeds; slugs of liquid refrigerant; valves or parts of the valve or stem working loose; and, with some valves, fatigue cracks from slamming due to faulty dash pot action.

* * *

Warm air coming in contact with cold piping and surfaces results in condensation with frost or rapid corrosion depending upon specific conditions. Therefore, insulation should be kept in good repair and uninsulated surfaces covered with a good corrosion resistant paint.

* * *

Irregular or abnormal operating conditions in a refrigeration system can usually be detected by thermometers which should be used at all important points such as: in the water lines to and from the condenser; main liquid lines leaving the condenser; compressor discharge and suction lines; and the suction from each evaporating coil or each evaporating unit.

REFRIGERATING PRACTICE

A Quick Purging System

By Merrill A. Radamaker

WE NEED air but not in a refrigeration system. The following diagram of a well arranged purge system is passed on to the engineer who wants quick results. The purge line runs from a condenser and receiver through valve P condensing the ammonia gas by means of the evaporating coil E. This is supplied by an expansion valve X connected to the main liquor line and returning the evaporated gas to a brine cooler, through valve R.

The ammonia condenses and settles in the bottom and the air bubbles up through the liquor, through valve PA and out of the hose connection to an open vessel. This should be filled with water to the overflow. Fresh water can be supplied when needed. Valve PA can be opened just enough to see air bubbles coming up through the water.

The liquor should not be lower or higher than the liquor line LL shown in purge drum. When the liquor goes to the maximum liquor line, valve D_1 should be opened and liquor released to valve D_2. This is the header valve that feeds the three C valves. Only one of these valves should be used when feeding this liquor through one of the branch liquor lines to the evaporating coils in the cold storage. The B valves are liquor supply valves, not expansion valves.

Sometimes it is possible to maintain a liquor range in the purge drum between the maximum and minimum liquor line, by regulating either one of the C valves with valves D_1 and D_2 wide open.

It is also possible to operate this purge system so that the liquor line in the purge drum will remain within limits by using a float at F. This should have an electric contact switch to operate an electric ammonia pump, placed in the line at Y with a check valve located at K. This method is preferred as it does away with hand operation so that the engineer can devote this extra time to other duties.

The ammonia system can be charged by connecting ammonia drum at valve O to the small liquor header, feeding through any one of the valves C to cold storage.

Stops Freezing on Spray Type Cooling Towers

By M. A. Rao

IN COLD climates, engineers have considerable trouble with the water freezing on the tower, especially when they are compelled to close the plant down for peak load hours, or, due to the small amount of refrigerating capacity required during severe cold weather.

To overcome this situation we have installed a large tank in the basement that holds the same amount of water as the spray tower pan on the roof. A 2 in. line has been connected to the return line from the tower just below the roof and near the ceiling at point A running to the tank in the basement.

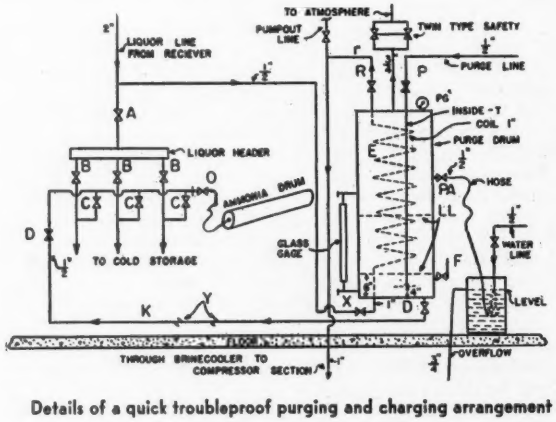
When the condenser pumps are stopped, the pan on the roof is drained through this 2 in. line to A by means of a valve D_5 to the tank. In this way all the water is drained from the tower pan, and at the same time the water is conserved until needed to start the plant operating again.

An additional feature of this spray tower is the winter line B used in regular operation, when the outside temperature is below 32 deg. F. By opening valve D_4 the condenser water is directed to the winter line B. This keeps the water from going to the summer line C and causing the spray water to freeze around the upper part of the tower.

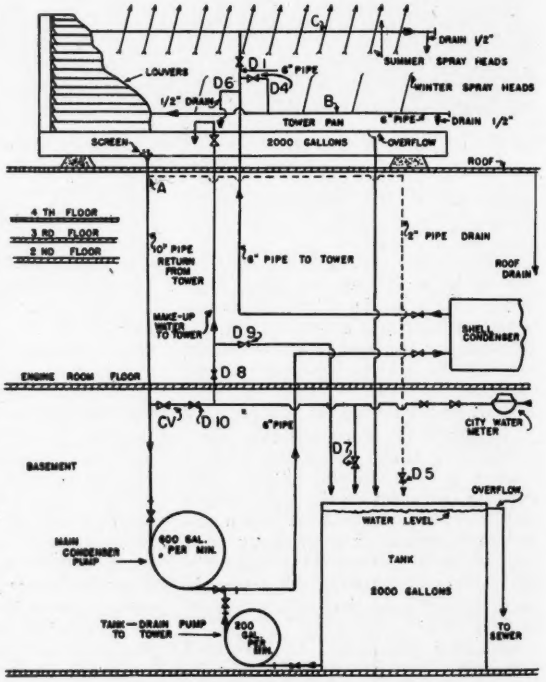
Valve D_1 is open at all times and is used only to cut out the summer line for repairs. It is possible to regulate valve D_4 by partial closing so that part of the condenser water goes to the summer line C in case the outside temperature goes above 32 deg. F. and the temperature of the condenser water rises. Half inch drains are provided as shown. They are not provided with valves as they drain continually into the tower pan. A spray head is placed on the end of each drain. This provides spray while the tower is in operation and also drains the line on which it is attached, when that line is out of operation.

There are three ways provided to supply make-up water to tower from the city water line. First, through valve D_8 to a float valve in the tower pan. This float line can be drained by closing valve D_8 and opening valve D_9, which drains to the tank in the basement. Second, city water is run into the tank through valve D_7 after which it can be pumped to the tower as shown in diagram. In the summer this tank is full of water at all times for emergency use. Third, city water can be taken in the suction side of the condenser pump through valve D_{10} and the check valve CV.

This basement tank (right) was installed to save water and eliminate freezing of the cooling tower



Details of a quick troubleproof purging and charging arrangement



BUILDING A NEW POWER PLANT

—As the Camera Records It

EARLY in August, 1940 the University of Illinois power plant at Champaign, Ill., is well under way. The superstructure is complete; the turbo-generators (two 3000 kw. G. E.'s) are grouted in, but, without insulation look naked like newly sheared sheep; one (A) of the three boilers (Springfields, each 80,000 lb. per hr., 325 lb., 650 deg. T.T.) is practically complete, drums and tubes of the other two (B and C) are in place and the stokers (D and E, B&W chain grate) are nearly completed ready for work to begin on the furnace walls.

The direct contact heater (F—Hoppes) is in place; painting the ceiling (G) has just started from scaffolding laid across the roof trusses; installation of one instrument and control panel (H—Republic) has just been started; but the crane (J—15 t. Whiting) has been in service for weeks. The main switchboard (K—Allis-Chalmers) is practically complete. This is of the double bus, metal clad type with oil circuit breakers. The operating voltage is 4160.

SECOND PHOTOGRAPH

A week later the turbines, filled in with well shaped and firmly laced insulation blankets, look less naked. One of the coal distributors (L—Non-Sec) is in place and the other is ready for hoisting into position under the coal scales (M—Richardson). The remaining two stokers are practically complete and the brickwork for No. 2 boiler has just been started. Boiler feed pumps (N—Pennsylvania) are being piped up and the first instrument panel, (H) now completed, is protected from damage by wood and corrugated board covers.

One of the turbines is designed for variable back pressure operation up to 70 lb. pressure and has one non-automatic bleed point. The other turbine is an automatic extraction (70 lb.) condensing unit exhausting to a 2500 sq. ft. Allis-Chalmers condenser. It also has one non-automatic bleed point. Extraction and exhaust steam will be supplied the University heating system at pressures up to 70 lb. while steam from the uncontrolled bleed point will be used for feedwater heating in a closed heater (Whitlock). Condenser water needed for summer operation will be cooled in a Marley forced draft tower.

The new plant, located on the west side of the campus in the direction of load growth, replaces an older plant uptown where expansion was not practical and ample coal storage areas not available. The new plant is tied in with the o'der heating system by a tunnel approximately 6 by 8 ft. in cross-section and carrying two 12 in. low pressure; one 8 in. high or low pressure; one 6 in. high pressure; 4 in. pressure return; one 4 in. vacuum return; one 2½ in. compressed air line; and space for a future drip return line.

For average season conditions it is estimated that the heating load will be about 60,000 lb. per hr. at 20 lb. ga. requiring a throttle flow of about 62,100 lb. per hr. for a turbine load of 2500 kw. Under these conditions about 90-93 per cent of the heat to the turbine will be delivered to the heating system.

THIRD PHOTOGRAPH

Finally the plant completed down to tile on the floor, numbers on the door and a horn for air raid (or other) signals. There are no curtain walls between the boilers and turbine. Note the ell shaped combined turbine and boiler pane's (the former facing the turbines, the latter the boiler aisle) for boilers No. 1 and No. 2.

Each boiler has a 33,000 c.f.m. (Sturtevant) forced draft, a 56,000 c.f.m. induced draft and a 4000 c.f.m. overfire air fan, all motor driven. Dust collectors (Buell) are located between the boi'er and economizer. Condenser auxiliaries include two hotwell pumps and two circulating water pumps (Allis-Chalmers); one of each motor and the other turbine driven (Terry). One of the three boiler feed pumps is motor driven (Westinghouse), the other two turbine driven (Terry). Hydrogen zeolite (Permutit) is installed for water treatment.

At times when the turbine exhaust is not sufficient for heating needs makeup steam can be provided through a pressure reducing and desuperheating station. All campus condensate returns flow to the deaerating heater floating on the heating supply line. Expansion in the 4000 ft. run of heating tunnel pipe amounts to about 110 in. and is taken care of by expansion loops on approximately 750 ft. centers.

The plant was designed by Sargent & Lundy, Inc., with Gustav A. Gaffert, mechanical engineer, in charge. C. E. Markland is mechanical operating engineer of the University and T. E. Richards is chief engineer of the plant.

Emergency Flashlight Repair

By Thomas Trail

SOMETIMES, when one is using a flashlight to illuminate a job, the lamp bulb will burn out. This may occur when another flashlight is not conveniently available. Sometimes when this occurs the flashlight may be restored to useful service and may remain serviceable until the job is finished, if the following procedure is tried: With the switch in the "on" position, strike the flashlight sharply, but not too violently, against the palm of the hand or some stationary object. At times the shock will cause the lamp bulb filament to fuse, restore contact, and the lamp to light.

For Better Softener Control

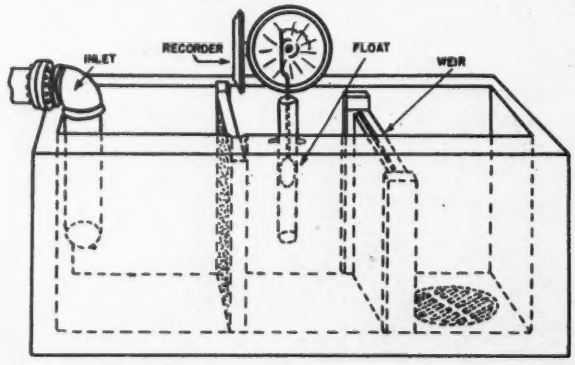
By J. P. Simons

MORE AND more plants are using zeolite water softeners and generally the power house crew are responsible for the operation and maintenance, and the ones blamed if hard water shows up anywhere in the system.

Satisfaction the equipment gives depends upon the way it is operated for even automatically operated equipment is subject to unforeseen stoppage and the manually controlled equipment may have a number of things happen. These interruptions or variations may pass unnoticed, or, may not be made known to those responsible for the operation of the equipment.

To check up on irregularities of any sort after they have happened is rather difficult. The operators may feel that some negligence is being looked for, or that someone will be blamed. Softeners do not ordinarily come provided with means of recording in a permanent fashion the actual handling of the equipment so usually this is taken care of by a log sheet written up by the operators themselves. While the exact operating cycle is established, there is no way the operators can prove that the information on the log sheet is actually correct.

As a means of protecting both the operators and the equipment a recorder may be installed as shown in the sketch. The float being in the weir box indicates the volume of water used as well as the time it was consumed. It allows a study of the brine added at various regenerations and indicates any water or zeolite waste. The chart will often clarify any low capacity of an individual softener for it tends to overcome any slipshod handling of the equipment by irresponsible operators.

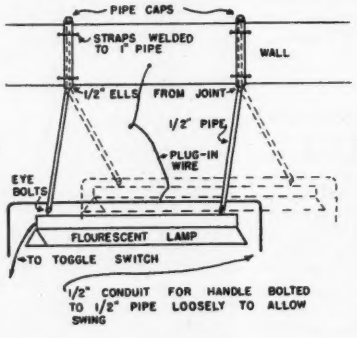


Simple float recorder installed to check up on the operation and regeneration of a zeolite softener

Movable Work Bench Light

By Frank Christenson

FOR SOMETIME we have been using a movable work bench light as shown by the attached drawing. The lamp is of the fluorescent type with a reflector mounted on brackets made of ½ in. pipe. Straps welded to the 1 in. pipe are bolted to the wall to support the lamp. Half inch pipe, held in the 1 in. pipe by pipe caps, are fitted with ells at the bottom which serve as movable joints. Conduit over the top of the lamp, loosely bolted to the ½ in. pipe supports, serves as a handy handle.



Swinging lamp improves workbench

A Troublesome Condensation Problem Is Solved

By M. R. O'Brien

WE HAVE a separately built gymnasium, about 30 ft. from the rest of the buildings and 5 ft. lower on a side hill, and trouble developed from the lines filling up with water after shutting down at night. It did not seem desirable to run the returns to an open end or put drain valves on, for they would have to be opened and closed nights and mornings, and the gymnasium is quite a distance from the boiler room.

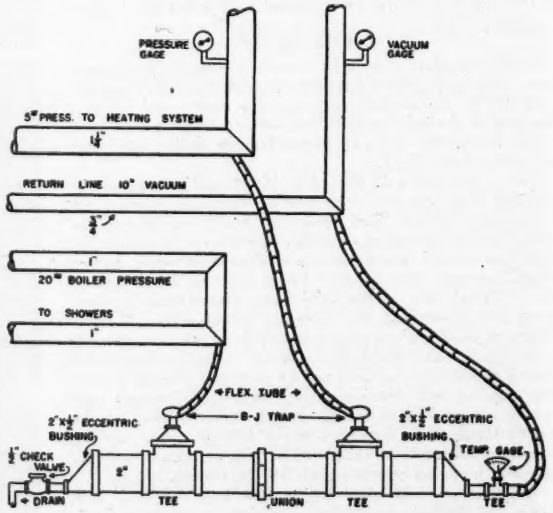
A 5 lb. pressure to the heating system is taken off the system in the nearest dormitory. There is another line, at boiler pressure, which runs to the showers. The return line ties into the dormitory return which carries a 10 in. vacuum on it.

As can be seen from the diagram, a receiver was made out of pieces of 2 in. pipe, a union and two 2 by 2 by ½ in. tees. Into each tee is a Barnes & Jones thermostatic trap. One end of the 2 in. receiver is reduced to ½ in. and the other end to ¾ in., using eccentric bushings.

Using flexible tubing to connect the drips to the traps, I dripped the high-pressure line to the showers to one trap, and the low-pressure line to the heating system to the other trap. The ¾ in. connection is tied into the return line. From the ½ in. connection a ½ in. pipe with a check valve leads to the drain.

While there is a vacuum on the return line, the check valve stays closed and the condensation returns through the ¾ in. connection to the return line. When we shut down and the vacuum is off, the condensation flows back from all the lines to the receiver and out through the check valve to the drain.

This arrangement has been working for over a year without any trouble and I can recommend it to anybody who has a similar situation and doesn't want to lose the condensation or go to much expense.



Arrangement used to drain steam piping either with or without a vacuum

Questions And Answers

Question No. 157

Checking Up On An Old Engine

WE ARE considering putting an old outside crank steam engine back into service. I have been told that it is out of line. How can I check on this quickly and from where should the measurements be taken? The engine has a barometric condenser and it is also said that trouble has been experienced in the past from flooding the engine cylinder. I do not see how this could happen with a barometric condenser.

N. Y.

Question No. 158

The Pump Discharge Is Milky

WE HAVE two pumps, pumping from a surface condenser and discharging to the same boiler. Both of these are of the duplex type horizontal steam pumps and both have separate suction and discharge lines. The condenser vacuum is about 4 in. abs. There are no leaks in the line and the pumps are in perfect condition yet the discharge from one is clear and from the other very milky. Can you tell us what the trouble may be?

Sidney, Mont. W. F. KRAUSE.

Question No. 159

What Valves and Packing Should Be Used

Q. WE HAVE in our plant a Worthington 6 by 4 by 6 in. boiler feedpump, the valves and seats of which have recently required considerable attention. Both are made of brass and the pump handles water at about 180 deg. F.

Would the use of composition valves reduce the maintenance? Also what type of piston packing should be used and how should it be installed?

Sandwich, Ill. L. F.

A. The large majority of Worthington's regular duplex boiler feedpumps are fitted with brass valves and seats. These are in general satisfactory for temperatures up to 212 deg. F. where the boiler feedwater is neutral. Sometimes where the water supply is alkaline, particularly where alkaline boiler compounds are fed through the pump, the brass fittings in the cylinder are attacked. For such cases we recommend stainless steel valves and seats.

If the deterioration of the valve parts appears to be mechanical rather than chemical or electrolytic, it is probable that so-called Bakelite valve discs would give good service.

For 180 deg. water, and assuming the pressure to be not over say 250 lb., we recommend Rockhard fibre piston packing rings. Care in the installation of the rings is important. The rings should be soaked for several hours in water at or about the pumping temperature and should then be fitted into the pistons while hot and flexible, making sure that: the ends of the rings do not buck together; that the joints of the rings are broken, that is, the rings with the joints 180 deg. apart; and, that the rings are not clamped between the piston head and the follower plate.

It is to be expected that further swell of the rings will occur after the pump is put in service. If the rings are originally tight between the head and follower, further expansion will force the surface out against the cylinder lining so hard that the linings will be cut. It is desirable to leave perhaps $\frac{1}{8}$ in. for further swell when the rings are first fitted.

The thickness of these fibrous rings can be reduced as required while they are hot by peeling off one or two layers of the fabric. Before fitting new liquid piston rings, the linings should be carefully examined and, if necessary, replaced as no ring will work satisfactorily in a scored lining or a lining which is worn barrel shaped.

W. M. FLEMING
Worthington P. & M. Corp.
Harrison, N. J. Chief Engineer
Recip. Pump Div.

Question No. 160

Thermal Conductivity Meters

WHAT is the operating principle of thermal conductivity meters and how reliable are the indications with different gases or gas mixtures? How are they used with internal combustion engines for showing the air-fuel ratio as mentioned in the article on p. 93 of the January issue? E. Z.

The fundamental principle of operation depends upon the difference in thermal conductivity of gas measured from that of a standard gas. The thermal conductivity of hydrogen is considerably higher, and, the thermal conductivity of carbon dioxide is somewhat lower, than the conductivity of carbon monoxide, nitrogen, and oxygen. This results in definite characteristic changes in thermal conductivity of different exhaust-gas samples.

Exhaust gas enters a cell containing a coil of resistance wire, which is an arm of a Wheatstone bridge circuit. A second cell, sealed and containing a standard gas, together with a coil of resistance wire, makes up another arm of the Wheatstone bridge circuit. The two remaining resistance arms are made equal.

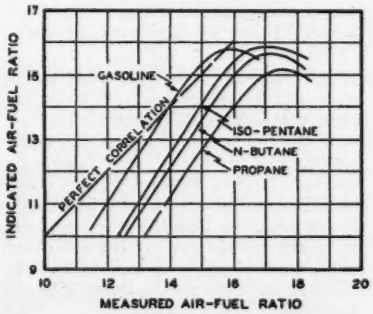
A controlled current from a dry-cell battery is passed through the bridge circuit and warms it to equilibrium temperature. In passing exhaust gas, of different thermal conductivity from the standard gas, through the test arm, difference in cooling of the resistance wires in the two arms causes a temperature change that affects the resistance and unbalances the bridge. This deflects the galvanometer over a scale.

Rich mixtures yield exhaust gases of high hydrogen and relatively low carbon dioxide volumetric percentages, thereby producing a gas of high thermal conductivity. Inasmuch as a definite correlation exists between hydrogen content and air-fuel ratio, it is possible to graduate a galvanometer scale in terms of air-fuel ratio. A calibration curve must be made for each fuel and several of these are shown in the accompanying curves.

In the very lean ranges the instrument had a tendency to return to readings of lower air-fuel ratio. The thermal conductivities of oxygen, nitrogen, and carbon monoxide are about the same, but the thermal conductivity of hydrogen is approximately seven times that of oxygen, nitrogen, or carbon monoxide, and the conductivity of carbon dioxide is about 40 per cent less than that of oxygen, nitrogen, and carbon monoxide.

For lean mixtures the hydrogen content approaches zero, while the carbon dioxide remains high. For very lean mixtures, excess air is introduced and the carbon dioxide content decreases. Oxygen, nitrogen, and a little carbon monoxide, in addition to the carbon dioxide, are all that remain in this very lean range.

Since the conductivities of these remaining gases are the same, and the carbon dioxide content is decreasing, the total conductivity will tend to become



Calibration curves of a thermal conductivity type air-fuel ratio instrument for various high volatile fuels as reported in Oregon State College Bulletin No. 14. For a very lean mixture the meter reads too high, giving similar readings for two different air-fuel ratios. This same difficulty is observed in CO_2 meters on natural gas where it is impossible to tell whether there is an excess of air or gas by this means alone

greater again. This causes the meter to swing back toward the lower air-fuel ratio and this characteristic is plainly shown by the droop in each curve.

The meter is used by arranging it so that a small sample of the exhaust gas is drawn through it continuously.

Answer to No. 125

Well, Blow Me Down, What a Hookup

C. W. Z. installed a new 285-hp. H.r.t. boiler with a "blowdown circulating system," as shown in the sketch. It didn't circulate and the unprotected pipe burned badly. He asked, on p. 92 of the August issue, five direct questions dealing with the theory; necessity for protecting pipes from direct heat; and on feedwater treatment. Other answers appeared on pp. 98 and 99 of the December issue; pp. 99 and 110 of the January issue and p. 98 of the February issue.

Feedwater Treatment Should Correct the Difficulty

1. THIS BLOWDOWN LINE, being unprotected from the fire, will act as a boiler tube, and generation of steam will take place. The steam would be released through the vertical pipe outside the setting and water would then enter from the drum, giving a ring circulation.

2. In general blowdown pipes should be protected from the furnace heat, since they are ordinarily dead ended. However, in this case circulation has been provided, and covering should not be necessary. Your experience, however, shows that circulation may not be sufficient, and several remedies may be used as follows:

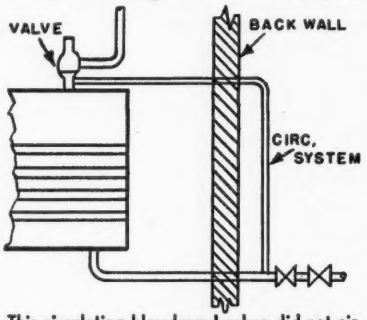
Cover the pipe exposed to furnace gases with refractory; however, leave the circulating pipe intact to help in cooling the furnace pipe. Install a gate valve in the circulating line which can be closed when blowing down the boiler, thus avoiding loss of steam through this pipe when blowing down. An upward slope to the blowdown pipe after it leaves the drum and a larger circulating pipe outside the setting would also improve the cooling of the blowdown line by increasing the circulation.

3. It usually is not desirable to put river water directly into a boiler, as high concentrations of mud and scale forming material may result. The writer has had several years' experience feeding clarified Mississippi River water directly to 185 lb., 500 hp. Heine boilers, and has found it possible to get good results by feeding sodium phosphate intermittently in quantities sufficient to maintain zero hardness in the boiler.

Considerable blowing down, both intermittent and continuous, has been necessary as well as washing out every 6 mo., but results obtained have been quite satisfactory. I would, however, be rather hesitant in feeding an unclarified water with high suspended matter directly to the boiler. If settling and clarification are not possible, very large amounts of blowdown may be necessary.

4. The mud scale would be greatly reduced in the blowdown pipe if it were protected from the heat.

5. To treat water for this boiler, internal treatment with soda ash or sodium phosphate may be used, maintaining a water of zero hardness in the boiler. Blowdown should be used sufficient to prevent foaming, priming, or carryover. Chemicals should be fed intermittently to the suction of the feed pump, either manually or by means of automatic timed feeder or proportioner. Obtain standard soap solution and a hardness testing kit from a chemical



This circulating blowdown hookup did not circulate as it was supposed to and consequently caused trouble

supply house or one of the companies specializing in water treatment as advertised in POWER PLANT ENGINEERING. Satisfactory boiler compounds are also on the market, and the companies selling them will be glad to instruct the boiler operator in their proper use.

In conclusion, I would like to suggest that your troubles with this line may be entirely a matter of water treatment and the trouble may clear up entirely if that angle is taken care of.

St. Louis, Mo. HENRY E. ZEFFREN.

The Final and Complete Answer

THE TITLE to this question is more appropriate than the hookup. Aside from the fact that this piping scheme violates all known boiler laws, one glance at the sketch indicates that it is anything but a blowdown circulating system, for it is obvious that no circulation could exist in this pipe line. As C. W. Z. voices his own suspicions in his first question when he asks if this hookup is any different from a water column connection. Rather than go into any lengthy discussion on why there isn't any circulation in this pipe line, suffice it to say that for all practical purposes it is identical to a water column hookup and one could easily ask—Where do you see any circulation in the glass on a water column?

The A.S.M.E. Boiler Code specifically prohibits any such arrangement as shown in the sketch. Paragraph P-277 states: "The safety valve or valves shall be connected to the boiler independent of any other steam connection, etc." If this boiler is located in a state operating under a boiler code, one would wonder how the boiler passed inspection.

It was also claimed for this particular type of installation that the blowdown line does not need any covering. Here again C. W. Z.'s informant was in error. The Boiler Code, paragraph P-312 states: "A bottom blowoff pipe when exposed to direct furnace heat shall be protected by fire brick, or other heat resisting material, so arranged that the pipe may be inspected." These requirements of the boiler code are based upon common sense, practical operating experience, and good engineering practice; the violation of these rules may result in personal injury or death and great property damage.

The usual method of protecting the blowoff pipe of an H.r.t. boiler is to build a small "V" pier of brick in front of the pipe, the apex of the "V" facing the furnace heat. The blowoff pipe is located between the two legs at the wide part of the "V". The pier is built from the floor to the bottom of the boiler shell, ending against the shell with a block of asbestos to take up the expansion and contraction of the boiler, which would otherwise knock the pier down.

Horizontal run of the pipe, if it is above the floor line, should be wrapped with asbestos rope up to the rear wall. If the pipe is below the floor line it should be placed in a trench with a loose brick covering so that the bricks can be readily lifted off and the pipe exposed for inspection purposes. The pipe should pass through the rear wall inside a sleeve with plenty of room between the pipe and sleeve for expansion.

In using water in a boiler, the source of which is questionable, the first precaution to be taken should be to filter it. This will eliminate the visual solids such as mud, silt, sand, small stones, etc. If the water contains scale forming matter, the cheapest thing in the long run is to call in a competent chemist and give him the job of controlling your boiler feedwater.

It might be well to point out, in connection with feedwater troubles, that both visual solids and scale forming matter, when once introduced into a closed vessel, like a boiler, must go somewhere. Now the problem is to make it go to and stop at the place in the boiler where it will do the least harm. Circulation of any kind in a boiler, either rapid or slow, natural or forced, has never and never will prevent scale formation.

It sometimes does prevent the impurities from settling—but the fact is that the impurities still remain in the boiler! Hence in setting an H.r.t. boiler it is usually the practice to pitch the boiler 1 in. lower at the rear, where the blowoff connection is, than at the front. This procedure enables the boiler to be thoroughly drained and easily washed out. It also has a tendency to cause heavy material, that may be in the boiler water, to the vicinity of the blowoff, where it will be removed from the boiler during the blowing down process.

From the above it will be seen that regardless of whether or not the blowoff pipe is protected, mud and impurities will collect around the opening and in the pipe. The only reason that the pipe is or should be protected from the heat is because there isn't any circulation of water in the pipe and should the pipe be exposed and generate steam the pipe

would become steam locked and burn up.

This condition can be prevented by covering the pipe. Furthermore, since the pipe is the lowest water containing space on the boiler and performing its duty as mud collector, an accumulation of impurities in an exposed pipe would surely cause it to burn up in short order.

Getting back to the circulating blowdown line, the sooner that line is removed, and the proper blowdown line is protected, the sooner you will have pleasant dreams again. With clean boiler water, and a given blowdown procedure, your mud and scale problem will be reduced to a minimum, and all of this can be accomplished without resorting to any trick piping schemes.

Williamsport. Pa. K. A. PIPPART.

Answer No. 135

Cleaning Boiler Tubes

WHAT, asked Homer Hulsey, p. 94 of the October issue, is the proper method of using an air driven tube cleaner, should it be allowed to feed its way in or be worked slowly backward and forward, overlapping a little each time? Other answers were printed on pp. 101-102 of the January issue.

Depends on the Scale H. D. B. Says

METHODS of operating a tube cleaner will depend upon the amount of and hardness of the scale in the tubes. If the scale is thick or if it is very hard the best results in cleaning will be achieved if the turbine is worked backward and forward overlapping a little each time.

When the turbine is pulled back the cutters speed up increasing the centrifugal force which drives the cutting edges deeper into the scale. When the turbine is moved ahead again the momentum of the machine helps to maintain its speed for a short distance as it cuts into the scale. This method of operating a turbine increases the speed and the efficiency with which the work can be done.

Where the scale is not too thick nor too hard good results can be obtained by allowing the turbine to feed in slowly, but care must be taken so that it does not feed in too fast for if this happens, much of the scale may be left in the tubes.

Lombard, Ill. HAROLD D. BROWN.

Let An Experienced Man Do It—But Where Does He Get the Experience?

TO CLEAN tubes with an air driven tube cleaner properly have an experienced man do the job. Most plants do not like to keep their boilers down long for "this necessary evil" and it has been my experience that most plants want their boilers "down" one day and "on" the next. To the experienced operator, whether he be an M.E., Supt., Chief Eng., Eng., Oiler, Fireman, Maintenance man (handy man to everybody else), knows what his boiler can do, and will do, when properly taken care of (we hope, we hope).

When cleaning tubes by air (or water) sufficient time must be allotted for tube cleaning, at least two men should be employed at this task, and take heed as to what our own P. E. & E. Colleague, Atomizer John[1], says about having good equipment. Overlapping each stroke when cleaning tubes, which is a very good method or you can let the tool feed itself by holding the hose up, depending upon the type of scale.

Too much stress cannot be put on the question of keeping tube cleaning tools in proper working order and to have above all proper air pressure in regards to the speed at which the tool must operate, and the proper tool must be had for a given size tube. And once again, give yourself plenty of time to do the job.

MARTIN N. GOZDENOVICH.

Fairview, N. J.

[1]Note what this old schoolmate of Pulverizer Pete has to say about care of cleaners on p. 91 of the October issue.

Answer No. 136

Burning Wood Waste on Stokers

ON PAGE 94 of the October issue H.G. wants to know if it is practical to burn wood waste on stokers without redesigning the furnace. In his plant, two boilers with underfeed stokers have recently been called upon to handle considerable quantities of wood waste due to changes in the manufacturing end.

This Is the Way to Do It

There are so many different types of wood refuse that it is impractical to suggest specific stoking equipment without further details. There is hogged fuel that gives much better results burned alone on a flat sawdust, or, wood, grate, preferably fed to the furnace from the top of a Dutch oven with the quantity of fuel and air both controlled. Slabs and other coarse wood burns when hand fired through the fire doors.

We are often supplied with a portion of the required fuel in the form of planer shavings (dry), sawdust and refuse from sanding machines. If properly arranged, this fuel can be burned to a decided advantage in a spreader type stoker set in a plain straight furnace. (Editor's Note: Details of such a setting and notes on operation are included in an article by the author and now ready for publication in an early issue. Details of another installation are given in an article on page 82 of the October, 1941 issue.

Care must be taken, however, to obtain the proper air and fuel ratio or trouble will be encountered. The regulators will shut off when the steam rises and unless proper allowance is made the CO_2 and also the furnace temperature will increase, causing rapid deterioration of refractory and grates.

If the wood refuse feed is reasonably even this adjustment is not difficult, but if it is inclined to come in large quantities and then in small quantities, a receiver or bin should be installed with a worm to feed the refuse to a chute where it will pass to the furnace by gravity. With this arrangement it is possible to feed the refuse at any rate desired and the air can be controlled accordingly.

Another stoker and arrangement to burn this type of fuel quite satisfactorily is the inclined front-feed stoker with the refuse fed to the furnace as described in my article "Boiler Tests Pay Good Dividends" published in the August, 1941 issue, page 102 of POWER PLANT ENGINEERING. This setup would work quite well even though some hogged fuel was included in the refuse. Natural draft is utilized with a regulator in the breaching.

Anyone contemplating a system to use wood with coal or wood alone should take necessary precautions to prevent what we might call slugging or choking of the furnace.

The setup for this type of fuel, that would cause the least difficulty, would be to install a storage bin to store the refuse as it comes to the power plant. Burn coal separate until sufficient wood is in storage to run for two or three or more days and then burn the wood alone until such time as the supply is gone and then go back to coal.

In this way the regulators can be marked for the best operation of either fuel and it is only a matter of a moment to change from one to the other. The arrangement described in my article on the Modernization of a Boiler Setting, to be published soon, would work out very well under these conditions. The main feeder shafts on the stoker should, however, be kept revolving when burning wood, so as to prevent warping tendency with the heat applied only on one side.

Milwaukee, Wis. B. H. WHITEHOUSE.

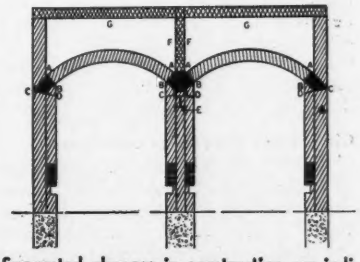
Answer No. 138

Why Furnace Walls Fail

FROM THE sketch (not reproduced in this issue) the reason for trouble with the Dutch ovens, as asked on p. 90 of the November issue, is quite evident. The entire weight of the arched roofs is upon the furnace lining, and not upon the outer walls as it should be. The method is fundamentally wrong. No matter how well you tie the arches in, no matter how good your refractories are, they cannot withstand excessive weight while at the temperature of the furnace.

To remedy the trouble, place the weight of the furnace roofs on the outer walls, as shown in the accompanying variation of the original sketch. The arches should be tied into the outer walls at C and D, not at A and B as that sketch showed. The inner part of the arches should be supported by building them from an "I" beam E, suspended by rods F-F from transverse I-beams G. This will leave the refractory lining of the furnace free to do what it is put in the furnace to do—protect the main wall from the heat. It isn't put into the furnace to support the roof or anything else.

GEORGE HOLMAN.



Suggested changes in construction are indicated by solid black and by the double cross hatched areas

LETTERS AND COMMENTS

We Could Do This

TODAY our country is fighting to preserve our freedom. Our Navy needs skilled men, and it is believed P.P.E. can do a valuable service by donating a page or part of a page telling what kind of openings exist in the Naval Reserves for qualified men and where they may enlist. Any time a P.P.E. reader enters the armed services it would be swell to mention the fact.

Augusta, Kan. J. C. DE FOE.

Editor's Note: Army and Navy recruiting stations are now so numerous that it is not considered advisable to attempt to summarize here information that can be obtained first hand at any recruiting station. Those feeling qualified by education and experience for a commission can also obtain information as to the procedure necessary. It is also well to contact the various local Army and Navy department offices to learn the specific need for specialists which vary from time to time. At present the greatest need is for men to fill various vacancies through the U. S. Civil Service, the employment agency for all federal agencies. The most pressing needs are listed below, following the first section of the P E & E Roll of Honor. For additional names we will have to depend upon the cooperation of readers. Please give name, former employer, date of entering service, branch of service and rank.

The First Roll of Honor

NORMAN J. MECKLEM, JR., author of the article Exact vs. Approximate Belt Length Calculations, on page 91 of the February issue, and formerly connected with the engineering department of L. H. Gilmer Co. of Philadelphia, is now Lieutenant N. J. Mecklem, U. S. A., stationed at Fort Benning, Ga.

Civil Service Engineering Jobs Open

The U. S. Civil Service Commission is accepting applications for all grades and branches of engineering. For the Junior grades, $2000 a yr., applicants are rated on their engineering education and no experience is required. Junior engineer, aeronautical, naval architecture and marine engineering, Announcement 122, age limit, 40 yr. Junior engineer, all other branches of engineering, Announcement 172, age limit, 35 yr.

In the upper grades, applicants are rated on education, experience, and record of accomplishments. In all but the chemical engineer examination, professional engineering experience may be substituted for college work:

Chemical engineer $2600 to $5600, Announcement 163. There is a shortage of engineers experienced in specialized branches of plant layout, equipment design, market analysis, chemical economics, heavy chemicals, plastics, rubber, agricultural by-products, and strategic minerals.

Naval architect, Announcement 98; marine engineer, Announcement 99; $2600 to $5600 a yr. Engineer (all other branches) $2600 to $5600 a yr., Announcement 173. Especially needed, particularly in the associate and assistant grades, are engineers experienced in the following fields: aeronautical, electrical, radio, telephone, mechanical (particularly machine design and development), heating and ventilating, industrial, sanitary, hydroelectric, irrigation, construction-estimating, structural, explosives, plumbing, public health, welding, hydraulic.

For all upper grades the age limit is 60 yr. except that for the highest three grades of marine engineering and naval architecture where the age limit is 70 yr. and the salary $3800 to $5600 a yr.

There are also opportunities in the subprofessional and lower grades: Technical assistant (engineering) $1800 a yr., Announcement 177. Engineering draftsmen, junior to chief grades in 20 different optional branches, $1440 to $2600 a yr., Announcement 174. Age limit 55 yr.

Applications for all these positions are being accepted for several months or until further notice but qualified engineers are urged to apply at once, unless they have already applied in a recent examination. Full information is given in the announcements which may be obtained (with the proper application forms) at any first or second class post office, or from the U. S. Civil Service Commission, Washington, D. C.

Says the Jacket Water Solution Is Fantastic

SINCE I did not submit a solution to problem 19 (p. 95, January), I feel free to challenge Mr. Sterret on his, and to criticize the judges for selecting as a solution an obvious impossibility.

Stand back and look at that problem again, for the engine is supposedly receiving the same quantity of heat and delivering the same output, yet with an increase of 50 deg. in the exhaust gas temperature plus a 15-20 deg. rise in the temperature of the cooling water.

In this problem as submitted by Mr. McKenzie it is evident that, since heat input and useful work output did not change, the heat causing the temperature rise in both exhaust gas and cooling water is waste which for 3½ yr. had been escaping from the engine through some channel other than work or cooling water, as this last remained constant. Note that I do not include exhaust gases.

According to Mr. Sterret's solution, this waste heat now escaping by way of the cooling water and the exhaust gases once escaped to atmosphere and surrounding objects by convection and radiation from the piston heads. According to Mr. Sterret, this waste heat cannot now escape through this channel because of carbon deposits partly or entirely insulating the heads. Not in these exact words, but in substance Mr. Sterret says this.

Every Diesel engineer knows that under normal operation the exhaust gases and the cooling water are the two principal channels of waste heat disposal. Mr. McKenzie did not state the quantity of water normally circulated or give the normal exhaust gas temperature. In the absence of exact figures, assume the exhaust gas for 3½ yr. was 500 deg. above atmosphere.

This may be wide of the mark, but it will serve to illustrate what I mean. With a temperature rise of 50 deg., this will give us 50 divided by 500, or a 10 per cent increase in the quantity of heat carried by the greatest of all carriers of waste heat, the exhaust gases.

Next, taking Mr. McKenzie's figures on the cooling water differential rise from 15 deg. (125—110) to 30 deg. (140—110) and we have here a 100 per cent increase in the quantity of heat carried away by the second important channel of waste heat disposal, the jacket cooling water.[1]

Now, even by assuming that the carbon deposits now insulate the heads perfectly, under present conditions, am I to understand that for 3½ yr. the piston heads of this engine dissipated as much heat as the cooling water circulating in scale-free jackets?

Am I also to believe that not only did the piston heads dissipate as much heat as the cooling water during these 3½ yr., but that even while doing this they also dissipated 10 per cent of the

[1]Note that this assumption, while in accord with the original statement on p. 95 of the November, 1941, issue, is erroneous due to the broken thermometer as explained on a later page of this issue under the prize awards for Problem No. 20.

quantity of heat being carried away by the exhaust gases? And what if the carbon deposits do not as yet insulate the heads perfectly, and some heat, say 20 or 30 per cent of the former quantity, still escapes through this channel?

Then under conditions existing for 3½ yr. which must be regarded as normal for this engine, the piston heads would have dissipated two or three times as much heat as the cooling water in clean-walled jackets. If the manufacturer of a Diesel claimed that the piston heads of his engine would dissipate as much heat as the cooling water circulated in scale-free jackets, plus 10 per cent as much heat as was dissipated by the exhaust gases, would you as engineers recommend it?

Remember that this must be true of Mr. McKenzie's engine if Mr. Sterret's solution is correct. For after the carbon deposits are removed the heads (presumably!) would go back to dissipating one-half of the heat now being carried away by the cooling water besides dissipating approximately 9 per cent of the heat now carried away in the exhaust gases. This in addition to any heat the heads may now be dissipating. I refuse to believe that the piston heads of any normally, and also abnormally, operating engine can get shed of anywhere near this quantity of heat.

If this were possible, why jacket the cylinders for cooling water at all? I could concede a degree or two rise in the temperature of the cooling water due to carbon deposits, and possibly a five or ten degree rise in the temperature of the exhaust gases. But the amount of heat Mr. Sterret attributes to dissipation through the heads is fantastic.

Turning now to the positive side of this argument, I am inclined to believe that Mr. Scott's solution came closest of all. I mean that part of it in which he mentioned the weight of air. Accepting Mr. McKenzie's statement that fuel characteristics, load and quantity of cooling water did not change, there remains only one thing which could cause such an extensive increase in the cooling water and exhaust gas temperatures. With constant fuel consumption, the quantity of exhaust gases must be less.

Moving back from effect to cause, a reduction in weight of the exhaust gases means also a reduction in weight of air used either for scavenging or for combustion, or for both. This probably means air at a lower pressure in the cylinder at the beginning of the compression stroke, and also lower pressure air for scavenging. If there is less air used in scavenging, the resulting mixture of scavenging air and products of combustion would escape from the cylinder at a higher temperature. The cylinder walls would remain at a higher temperature, and with less scavenging air to cool them, would also transfer more heat to the cooling water.

Also, with less excess air for combustion, the pressure rise on the compression stroke would be less due to less air and more due to higher temperature, that is, one would iron the other out, while the higher temperature and richer mixture of air and injected oil would probably make the combustion process more efficient. This presupposes too much excess air during normal 3½ yr. of operation. The overall result would be a smoother going engine, with better economy, as has been noted by Mr. McKenzie.

Although the facts of the case point to slowly clogging filters in the air supply, the trouble may lie in intake or exhaust ports gradually filling in with carbon deposits. Mr. Bradley comes close when he mentions a clogged exhaust port. A partly clogged exhaust port would cause inefficient scavenging, but would leave warmer walls and warmer combustion air, and probably would advance ignition.

Under some conditions advanced ignition will make a Diesel smoother going. Certainly less excess air at a higher temperature, if sufficient for complete combustion of the fuel, ought to improve combustion, advance ignition and directly result in higher exhaust gas and cooling water temperatures.

GEORGE HOLMAN

When Welded Boiler Repairs May Be Made

INASMUCH as many engineers are unfamiliar with the new regulations governing fusion welding repairs on boilers and pressure vessels, it doubtless will not be amiss to enlighten them regarding these rules, since it is indispensable that each person do all in his power to further increased production. By strictly adhering to these rules, considerable time and materials will be conserved which can be diverted to other sources.

Regulations should be rigidly followed. Otherwise, serious consequences may ensue. For example, where a qualified welder is required, an unqualified one cannot be substituted, for there might not be only a contravention of the State laws, but might well lead to a disastrous explosion with considerable delay in production and loss of life.

The National Board of Boiler and Pressure Vessel Inspectors on March 6, 1941, promulgated "Recommended Rules for Repairs by Fusion Welding to Power Boilers and Unfired Pressure Vessels," that is boilers and pressure vessels operated at over 15 lb. pressure. Prior to these regulations, the rules, broadly speaking, were to the effect that high pressure boilers could only be welded when the strain or stress was carried by other members. That is, in areas which were supported by staybolts or braces, the idea being that the bolts or supports would prevent the disruption of the sheets should the welded repair fail.

It has been successfully proven that fusion welding, when properly accomplished, is as safe as any other type of repair, and so, as a corollary, the aforementioned rules have been recommended by the N. B. B. & P. V. I.

In following these rules, it must be borne in mind that each State has regulations covering boilers, and, some States have rules appertaining to pressure vessels. Therefore, before any kind of repairs are made to boilers and pressure vessels, it is necessary that the inspector having jurisdiction be called, in order to definitely ascertain if the repair can be made in accordance with the National Board Rules and the inspector's approval received. These rules are to be used only for repair work, as in new fabrication the various State Codes must be followed as adopted.

Pittsburgh, Pa. J. J.

EDITOR'S NOTE: *The author also suggested that these rules be published serially in the P. E. & E. This is obviously unnecessary for they have already been published in a 12 pp. 6 x 9 in. booklet. This is available, free of charge, from C. O. Myers, Secretary-Treasurer, The National Board of Boiler & Pressure Vessel Inspectors, 1006 Brunson Bldg., Columbus, O. The complete title is "Recommended Rules for Repairs by Fusion Welding to Power Boilers and Unfired Pressure Vessels. (Revised Mar. 6, 1941)."*

Inasmuch as some of the statements made in the rules are of necessity general and subject to interpretation, and, the question of welded boiler repairs is a matter of almost universal application, we have a further suggestion.

Write and get your copy of the rules, study them over and send your questions in to P. E. & E. to be digested in the Open Forum Mill. We will classify the questions and endeavor to have them answered, individually or collectively, by a competent authority, for publication and further discussion in these columns.

Paralleling D.C. Generators

COMMENTS and the diagram of Donald Osterhoudt (January 1942 issue, p. 106) are of historical interest. To those of us brought up in the larger cities, 3-wire generators represented, when introduced, a great advance, as they saved space and increased efficiency. Information about paralleling connections may still be found in handbooks, notably one of national prominence.

The original N. Y. Edison units consisted of two separate generators driven by one engine. This system had advantage over a 3-wire unit since the amount of unbalance was not limited as in a 3-wire machine and the generators were not of special design. The 3-wire unit had also the added complication of two to four collector rings and its balancing coils usually mounted separately.

A straight 2-wire generator being a standard product enabled 220 to 250 v. or higher to be generated and used for power service, while a balancer set was made up of two 2-wire units which could be loaded to any degree of unbalance. By cross connecting the fields very accurate balancing resulted.

The increase in the number of installations supplied from central station service with 3-wire one-phase or 4-wire 3-phase service naturally resulted in less demand for 3-wire d.c. units. The central station supply changed, from d.c. generated by separate generators driven by one prime mover, to one where the d.c. came from synchronous converters.

Brooklyn, N. Y. C. O. VON DANNENBERG

ENGINEERS AND WHAT THEY AIN'T—Concluded!

DEFINITELY and irrevocably (perhaps with our fingers crossed like Harry Lauder when arranging his American Farewell Tours year after year) this perennial discussion is being concluded this issue.

Engineers and What They Ain't (p. 86, April, 1941) was a caustic indictment of modern commercial engineering, painting a doleful picture for the young (ipso facto as Lawyer Evans Chew would say because of 4 yr. treading Marble Halls) engineer expecting glamour, wealth and power. Positions at the top are scarce; those at the bottom sometimes scarce, sometimes plentiful; and the whole system is set up to keep the overly ambitious from climbing out of the niche they occupy.

Hot and heavy came the replies, some agreeing, some disagreeing and others ranging all the way from the Bible, through Aesop's fable of the Fox and the Sour Grapes, to Kipling, modern verse and grammar. Some of the letters were printed in subsequent issues (p. 86 and 87 in May, p. 95 and 96 in June, p. 96 in August and p. 104 in December).

The original article was anonymous, signed only "by one who isn't either" and has quite generally been referred to since as "Mr. Ain't." Mr. Ain't prepared a rebuttal (p. 86, November) reaffirming his original position with the positive assertion "I Still Say They Ain't."

Perhaps he was not overly persuasive for we noted a decided increase in enrollments in engineering colleges last fall whereas we expected a decided decrease following this daring exposé. Seriously, though, this problem of engineering education is not a new one nor one that has been neglected.

Not every one who studies engineering has the mental and physical qualifications to make a good engineer. Nor is there a top position for everyone of those who has the necessary qualifications. Of necessity many a potential Newton, Einstein and Edison are destined to play a minor part supplying the world with food, shelter, clothing and such luxuries as circumstances permit.

Perhaps some day psychologists can definitely say "You are a potentially great chemist." "You should be a machinest," etc. Then each could be educated to the limit of his capabilities so as to fit nicely into his predestined niche. Never too many engineers, never a scarcity; always enough to eat and no shortage; just the right number of shoes and automobiles each year; and no Hitlers to upset the applecart.

But for the present, that is disregarding the abnormal war conditions, we must remember that roughly only half those who study engineering actually practice it afterward. If more and more people are going to more and more schools, the real question is, does or does not an engineering education offer a wider scope and background for diversified activities in our present mechanical civilization than does, say, law, medicine, the arts, or agriculture? While it may not be economic, educating a nation beyond its intelligence level is certainly preferable to the opposite extreme and stopping just beyond the threshold of illiteracy.

The Town Banker and Drunk Become Involved

FOR THE umpteenth time the argument pertaining to the merits or woes of an engineering career arises within our midst. Ever since "One Who Ain't" started the argument, words have waxed hot and furiously. In the language of Pulverizer Pete, I say nuts to much of present so-called engineering. How many times have you, mister engineer, been called to the control board and found the gages reading anything but right and how many times under such conditions have you been willing to admit that whatever is wrong might possibly be your own fault?

Perhaps many of you have, but there are also many who will have blamed other things—the fuel, the water, the gadgets or the instruments themselves; maybe they are faulty. Perhaps it is not your fault, but as an engineer you should know that the instruments are right, you should have been checking and adjusting them when you were gabfesting with the oil salesman or reading that copy of "Hair Raising Thrillers" he left behind. Perhaps you should do a little towards earning your weekly salary instead of accepting it as charity.

I am not a college graduate, but what virtue is there in hauling out an engineering degree when, if the truth were known, you know the foreman at the local power plant knows more in the way of practical engineering than you will know for many years to come.

I'm not saying this is true for all engineering students, because there are those who bring engineering to its great glory. But there are too many people who call themselves engineers when really they are better fitted to be dry goods merchants. Many of us can remember that "golden age" of the gay '90s, where possibly only the son of a banker went to college to study engineering, and when he came back with his M.E. degree, he was considered an "Alger hero."

Yes, but was he the town's successful engineer? Hardly; it most likely was the cobbler's son or even the son of the town drunk who would scarcely have time to finish grade school. In his spare time he did his mechanical studying probably in some old dilapidated boiler room after the daily chores.

Of course, this is only one man's opinion, but considering the state of affairs 50 yr. ago, the percentage of fellows who made it the hard way probably surpass those who were handed golden platters. There are a lot more engineers to contend with now than there were 50 yr. ago, the equipment in use is vastly different. With automatic equipment, about the only item that needs close attention is the control board.

So *you* think. There is a lot more to engineering than that. The equipment requires maintenance; daily tests should be made of various instruments, records must be kept and analyzed and, above all, you should know at every instant how well all your equipment is functioning. If you are able to do that, if in keeping the plant running in top notch condition you are still able to exhibit a keen interest in all aspects of your work, you are probably an engineer at heart and then if you still have time to spare to read your "Hair Raising Thriller" why go ahead and do so.

Chicago, Ill. CHUCK SANDERS.

Engineering Is a Way of Thinking

THE NOW-FAMOUS Mr. Ain't really has something on the ball. He seems to be one of the few engineers who has taken time out to unravel the intricacies of a profession, a man who has enough courage to sit back and think about his profession in a logical, unbiased way and so is to be admired. After all, he selected his profession, studied, and undoubtedly went through a certain amount of misery to obtain his desire. To doubt his earlier hypotheses and conclusions shows that the man is rational. It also shows that he has trained his mind in a scientific manner.

The writer has tread through Marble Halls, stood many a lonely 12-4 watch on a groaning old freight ship, slipsticked here and there, and also has operated machinery on dry land. He feels that as a result of this experience he has picked up enough miscellaneous data which may be offered for or against the cause of Mr. Ain't.

Mr. Ain't really overemphasized certain phases of the influences affecting the choice of engineering as a profession. As far as the writer can recall, the youngsters who decided to study engineering with him had just one idea in mind. It was something like the following: "Some day I will have to support myself, and when that day comes I want a nice home and car. An engineer makes enough money to supply home and car, therefore, I will study engineering."

Those thoughts were very nice, some people even went so far as to admire the "logic" involved. However, when vectors began to hit the boys between the eyes, many of them felt that there were better ways by which the money for home and car might be obtained. Result, the engineering department had twenty less students the following year.

The profession does not offer everything that one thought it would. But, does medicine or law fulfill all the ambitions of their followers? Financially, yes, but mentally, no. It has been observed that there are very few men in this world who are really satisfied with their life's work, whether they chose it, or had it forced upon them.

It also appears that something must be lacking. The average man (there are quite a few average engineers, you know) should be satisfied with his calling if he chose it. The writer feels that in the last 40 yr. too much emphasis has been laid on the material side of a profession. One never hears of the mental satisfaction he may derive from his profession.

The writer feels that the young engineering grad should apply some of the principles he learned in the laboratory. During the first years after graduation the young engineer should operate a few machines, try his hand at some drafting and design work, and if he feels in the mood, he should try to sell. After 5 to 8 yr. of varied experience he should be

able to come to some definite conclusion as to the branch of engineering for which he is best suited. He has spent a total of from 9 to 12 yr. "finding himself." Fine. If a man has enough intelligence to be able to figure himself out in that time, he should be complimented.

During this experimental period the engineer should try to learn a little about engineering. After all the average college can't squeeze enough into 4 yr. to make an engineer out of a man. There is more to engineering than just cold facts. The young man should try to learn of some of the beauties of his profession. He should delve into the fundamentals, read the lives of the great scientists, should try to develop a philosophy based on his knowledge of science. He needn't try to sell these ideas, they are for the purpose of making a better engineer of himself.

Engineering, after all, is a way of thinking. It can be applied to life, and if properly applied, will reap many rewards for the individual. He will realize that there is something beautiful about it, that it, too, may be beautiful and poetic as any of Shakespeare's lines. The writer believes that engineering, properly applied, will even help a man when he is concentrating on the wenches. Just try it, brother.

Let us sum it up as follows: To be interesting a career in engineering must be varied. The engineer should know what he is looking for. It is seriously thought that an evening spent thumbing through Mr. Kent should be more enjoyable than an evening with a detective story. He should try to find his proper place in the community. Mr. Ain't has the right ideas. Perhaps the slight exaggeration mentioned above was due to the fact that he wanted to put his ideas across with a bang.

New York, N. Y. TYLER G. HICKS.

Don't Blame Mr. Hays

AFTER READING Mr. Ain'ts' rebuttal I would like to take another crack at him, for you see I like the guy. By his own admission, he is 32 yr. of age. Therein the nature of his difficulties becomes more apparent. It is exceedingly probable that he left college at the darkest moment in the economic history of our country. Admittedly, competition was, and is, terrific in all fields. Quite humanly, he failed to reach the mark set by himself. He has passed through periods of anger, disgust, distrust, disappointment, and, finally, frustration. Now as an escape, he throws mud at the engineering profession.

Why doesn't he consult one of the laboratories in "Human Engineering," and discover what sort of work suits him best? Quite possibly, he is not an engineer. He has ideas, and perhaps would make an excellent writer. I think so.

The engineering profession has done more for the human race than has any other field of human endeavor. Our engineers in the fields of sanitation, transportation and communication by developing to a high degree in the principles of the division of labor, have enormously enhanced the physical welfare of all of us. In doing so, they have made more leisure available to us, to be used for the development of the creative mind, and for explorations into the field of abstract thought and pure science.

Contrary to the prattle of reds, radicals and parlor pinks, there is plenty of room at the top. Death, plus the ever widening field of science assures us of a mark to shoot at. Naturally, we are not all of the same mental caliber, but we can do our best. If we fail, let us study the cause of failure, then try another angle of attack.

As for escapist reading, it can be used as a means of escape from realities, or as a way of determining the exact nature of the realities. And we work from there. For example, the saying "Life seems poorest when we are richest" can be interpreted as we see fit.

The definitions of "trade" or "profession" are largely matters of opinion. If a garden variety of engineer, such as myself, should design and build a house, design and install the plumbing, heating, lighting and sanitation systems, if he should construct a cartridge case to his own liking, and design projectiles for his own specific use, if he purchases and installs a water wheel near a dam of his own design and construction, and operates a sawmill of his own make, why, by the standards of our present system of considering such achievements, he will be "working at his trade." However, should he have a sheepskin, and a license to practice, he will be an engineer, and his work will be engineering. So what? The results are the same. He has a house to live in, and a mill to earn his living.

Naturally, in an industrial world such as ours, a certain amount of standardization is necessary, and desirable. This standardization is another means of extending the division of labor. Without division of labor we would be reduced to the ranks of the most absolute savage. Do not overlook the fact that, to obtain this standardization, there is necessary a tremendous amount of the most rugged and powerful individualism. The only standardization the writer regrets is in the field of education. What cute little robots are turned out.

Incidentally, I do not blame the Hays office for my lack of success with the wenches. Something to do with the physiognomy, I guess.

SAM WILLIAMS.

It's barely possible that this is what Mr. Hicks means

Life's Greatest Find Is Peace of Mind

NEVER FEAR, you have no reason to regret publishing the articles by and about engineers. By so doing you performed an important service to all engineers for the reason there is a great human side to engineering never touched in technical articles.

To illustrate what I am driving at, I go to night school two nights a week, from 6:30 to 10:30 o'clock, at the University of Pittsburgh. I get quite a thrill out of this but do feel a little out of place among the young lads, all of whom are young enough to be my grandsons.

My partner and I were running some tests the other night, and while we were recording data our test overheated and blew up, hitting the ceiling. I supposed the test was ruined, but after things quieted down I was surprised to find the pure concentrate left.

So it is in life. I believe the fine part in the lives of the boys who took part in the discussion is still left. The only regret I have is that they abused each other so, when there are so many nice things could have been said which would have been of value to all of us.

We are told that it is an unpardonable sin for a writer to say "I did so and so", but what we want to know is how and what the writer did without too much worry about grammar and composition. I believe the P. E. & E. could do no finer or more useful thing than devote a couple of pages each month to the human side of engineering. I would like to have the personal experiences of personnel men, inspectors, foremen of all kinds, salesmen, etc., since an engineer today must be all of these.

The milestones that we pass
Bring to us no fear
If our mirror can reflect
Faces with conscience clear.

Pittsburgh, Pa. HORACE S. BRACKEN

Hoist By His Own Petard

ONE OF our Nebraska newshawks reports that Lee J. Ruf, superintendent of the Nebraska Power Co.'s Omaha Steam Plant (Jones Street), now has a full appreciation of the importance of power service continuity from both sides of the fence, i. e., the consumer and supplier.

The Ruf's were entertaining some N. P. Co. friends in their electrically equipped suburban home New Year's eve when a driving snow storm staged a complete blackout. With highways blocked and with no light, heat, water or power, guests remained overnight, learned of the eccentricities of candles and wood fireplaces and gained a new slant on the vital need for power in a modern world.

Problem 20. Wiring for Our Hero's New House

How Would You Do It?

A NEW SLANT ON PROBLEM 19

Our Hero is in hiding and his friend Mac is red faced about the rising jacket water temperature (see p. 95 in the November and p. 95 of the January issues). It was all a mistake! Mac discovered that the thermometer on the soft water outlet of the heat exchanger was cracked —right under the metal band where it was not noticeable. Regardless of the temperature the thermometer read 110 deg. F. while actually the temperature was about 125 deg. F.

The soft water side was scale free—but the raw water side—well, Mac was a bit hasty, there too, for a more thorough inspection disclosed scale—in fact enough had built up over the 6 mo. period to boost the mean temperature difference 15 to 20 deg. in order to get the necessary heat transfer. The problem was strictly on the level, however, the broken thermometer was only discovered the other day, long after experts from one end of the country to the other had doped it all out.

On top of all this Mr. Holman in the Letters and Comment section a few pages ahead says, "Look at that problem again for Mr. Sterret's prize solution simply cannot be possible in practice, on paper, or, anywhere else." Mr. Holman, who did not enter the contest, says he feels free to criticize the award—and he pulls no punches.

WHILE MANY insisted on treating Problem 20 as a trick question difficult of solution, it was in fact a very practical one on wiring and switching. In brief the problem was to arrange lights in several rooms so that they could be turned on and off at either of two master switches and yet, in case of need, be responsive to individual room switches.

It was not unduly complicated except for the Judges who tripped over their whiskers and got high blood pressure over a kickback on Problem 19 which was supposed to have been thoroughly disposed of 2 mo. ago. By hiring a fifth columnist (spy, not journalist) to follow the secret judicial deliberations through the keyhole we have a fairly complete report of the meeting, that is up to a certain point.

Remindful of the strenuous session with Problem 19 about Mr. McKenzie's rising jacket water temperature, the Judges first tucked in their napkins (one corner on each side of the neck with the whiskers well covered) and made a rush for the smorgosbord to get a strong start on Problem 20.

The Chief Justice, who is a bit nearsighted anyway, got his whiskers mixed up in the celery and lost track of the argument over smoked vs. pickled herring. As everyone else was engaged in small talk, he carefully wiped the anchovy paste off his fingers on the tablecloth, reached over and picked up the top letter from the pile waiting judicial attention. This told how Mr. McKenzie had no rising water temperature at all but only a cracked thermometer. To lower his blood pressure the old boy yanked off his napkin and began to click his false teeth at the perfidy of the human race in general.

Unfortunately this lowering of his guard proved to be a technical error, for, when he got a glimpse of Mr. Holman's letter saying, in effect, that the whole bunch of Judges were a bunch of screwballs, he swallowed his teeth. With a dexterity born of long practice two of his cohorts held him up by his heels while a third pounded him on the back.

The Junior Judge, whose beard is only 2 ft. long and who has not yet learned to curb his curiosity, picked up a third letter, one from John Rusniak of Lincoln, Ill. The Chief Justice got his false teeth under control just in time to hear "It is hard to believe that there exists such a problem today."

With this the Chief Justice lost his appetite completely and threw his lunch at the door. After this frontal attack our Fifth Columnist beat a strategic retreat to the hospital area to have a meat ball dug out of his eye and then went off on a war of his own because he claimed the chef put lye and ground clinker in the meat ball sauce.

With our espionage organization wrecked we can tell you nothing of the secret deliberation about Problem 20 beyond the awards themselves and the Judges' terse comment that: the awards were made primarily on the basis of a practical and simple wiring diagram to accomplish the desired result plus, as embodied in the accompanying text, an obvious appreciation of the problem from the standpoint of Mrs. Hero and code requirements.

While differing in detail, all three prize awards use the same fundamental arrangement of three way master switches and individual switches. In fact the majority of entries made use of substantially the same scheme so that the awards were of necessity based primarily on the description and explanation. A number, however, submitted more elaborate schemes incorporating multipoint rotary switches, relays and magnetic contactors.

Whether our Hero will be able to utilize the ideas submitted is problematical. You may recall that his wedding was well before Pearl Harbor and before Mr. Nelson got really tight about building materials. In the light of ensuing events Our Hero has been giving some thought to this matter with particular attention to sod house architecture as practiced by the pioneers in the prairie states.

FIRST PRIZE AWARD

A. R. Markland
Altoona, Pa.

SINCE the house in question is rather small and 30 amp. 3-way flush tumbler switches are now available for use as the master switches, the emergency lighting system simply involves the substitution of 3-way switches, for the single pole switches usually installed to control the room lights and a 4-way switch for one of the 3-way switches on the hall lights along with the extra fuses and wiring for feeding the lights from the master switch.

The 1940 National Electric Code, Article 2108, calls for a lighting load of 2 watts per sq. ft. for single family dwellings except that under a floor area of 500 sq. ft. the load may be assumed as 1½ amp. per outlet. Also it would be necessary to keep the load on the

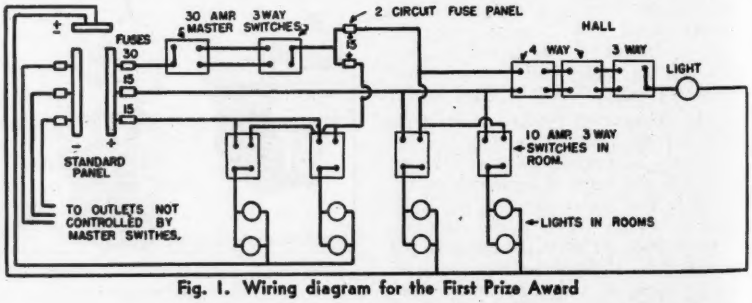


Fig. 1. Wiring diagram for the First Prize Award

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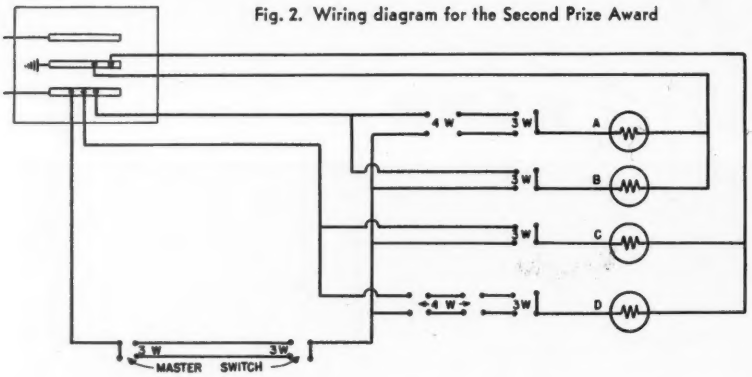

Fig. 2. Wiring diagram for the Second Prize Award

branch circuits below 15 amp. according to Article 2125.

The entire scheme is shown in Fig. 1, although if the total load in the rooms were below 15 amp., the master switches could be reduced to 20 amp. size and the 2 circuit fuse panel could be omitted.

In installing this system it would be desirable to connect the room switches so that the lights would be supplied by the regular source when the switch handles are up. Another suggestion is that the lamps be installed in locked keyless sockets.

SECOND PRIZE AWARD

C. L. Gramley
Aurora, Ill.

OUR HERO, who now has double trouble, can use the diagrams in Fig. 2 as a basis for a house wiring plan in conjunction with a master control circuit. Some 15 or 16 yr. ago I first used this scheme in a $28,000 house. When ready to install switches and trim, a salesman from one of our largest switch manufacturers said it would not work because it was not included in the company's diagrams. I asked him to furnish the type of switches I wanted in the style my customer selected, and I would pay the penalty. The circuit worked and is still working, and is now included in Mr. Salesman's files.

Light A is any lamp or fixture normally controlled by a 3-way system. Light B is any normally controlled by a single pole switch. Light C is a light in the master bedroom normally controlled by a single pole switch. Light D is any lamp or fixture normally controlled by a 4-way system.

These four are used to show that any number of lights and any combination of switch control system may be included in the master control circuit. You will notice that there are no remote control or solenoid contactors of any kind used, which tends to keep costs to a minimum.

It is very simple if we bear in mind that any fixture normally controlled by a single pole switch has a 3-way switch instead, with the shunted end leading to the fixture, while one of the transposing terminals receives the potential side of the circuit (black wire) and the other transposing terminal is connected to the leg of the master circuit.

In a normal 3-way system (A), a 4-way switch is used on the end of the circuit, where the potential or black wire would normally be connected, and the spare transposing terminal is likewise connected to the leg of the master circuit. A 4-way system is connected the same way, bearing in mind to replace the 3-way switch on the hot end of the circuit, with a 4-way, and also connect the spare transposing terminal to the master circuit leg.

I have purposely placed A and B on one circuit, and C and D on another to show that it does not create any confusion. Whenever I install this system though, I have been careful to supply current to the master system from the same side of the line as the other light switches were fed from in order to avoid a 220-v. arc across switch contacts. This, however, is not imperative but precautionary, as these switches may be used on 220-v. current.

The master circuit which Our Hero wishes to control from two points is a simple 3-way system with its leg, instead of being connected to a light, is connected to the above circuits as directed.

A careful study will show that when the master circuit is on, that no light on the independent circuits may be extinguished for any effort to do so simply transposes them to another circuit, or, if one or more of the independent lights had been lighted previously by its own switch, they may not be extinguished by the independent switches, for any movement of any independent switch would transpose the light to the master circuit.

I would suggest to Our Hero that the master control switches be placed in some semi-inconspicuous places, to avoid being observed by intruders.

THIRD PRIZE AWARD

Carl A. Myers
Shift Engineer, Weadock Steam Plant
Consumers Power Co., Essexville, Mich.

ALTHOUGH there is more than one way to satisfy the wishes of our mythical character, by keeping the conservation of material and code requirements in mind, I believe the solution shown by Fig. 3 is an economical one. This scheme, if desired, can utilize a duplex switch for each circuit, part of which is to be subject to control of either of two master switches.

The duplex switch is comprised of two switch units, each unit being of the toggle type and both simultaneously operated by one lever. One unit is a single pole switch and the other a 3-pole. The combined switch mounts in the conventional switch box and accepts the ordinary switch plate. From all outward appearances it is no different from the usual wall switch.

Figure 3 shows the fixtures to be controlled in part by the master switches, as of different types in respect to the number of sockets. This, as shown in the diagram is for explanatory purposes only. It will be noted that the fixtures having more than one socket have one of the sockets disconnected from the remaining sockets. The lone socket of each fixture is connected to the 3-way switch which may be part of the duplex unit. The remaining sockets of each fixture is controlled by the single-pole switch of the unit.

Connections should be made as shown in the diagram, each fixture connected alike to its control switch. As can be seen, the wiring of this part of the circuit

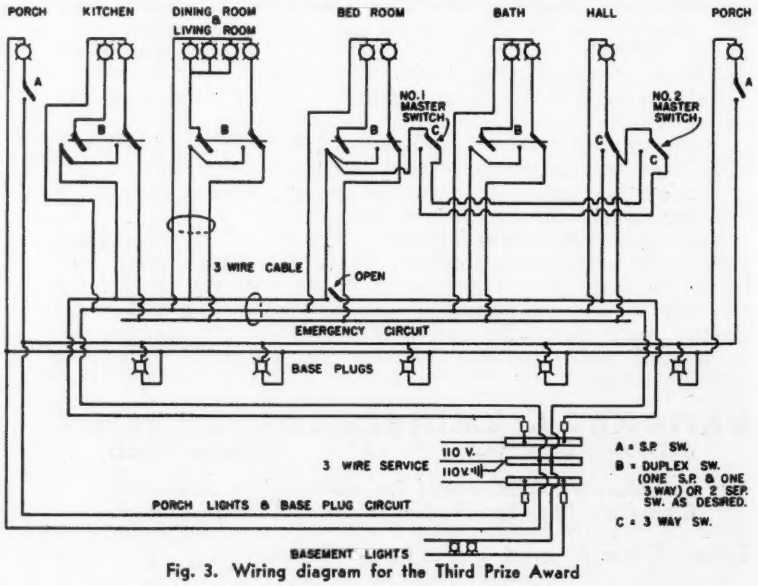

Fig. 3. Wiring diagram for the Third Prize Award

A WAR MESSAGE
to
ALL EMPLOYERS

★ From the United States Treasury Department ★

WINNING THIS WAR is going to take the mightiest effort America has ever made—in men, in materials, and in money! Every dollar, every dime that is not urgently needed for the civilian necessities of food, clothing, and shelter, must, if we are to secure final Victory, be put into the war effort.

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GPO 16—25943-1 Form No. DSS-BP-2

is made with a 3-wire combination or cable of the common type for home wiring with two insulated wires and one bare wire.

The bare wire is the neutral or ground wire and connected in this circuit as such. One of the insulated wires is used throughout the circuit as the emergency circuit wire. The remaining two wires are the main feed circuit.

It might be suggested that the 3-wire cable be run in the basement or below the floor. Connections to be made in junction boxes located below each duplex switch position. At each junction box connection is made to the switches and to the fixtures with more of the 3-wire cable.

In the diagram the 3-wire cable runs between, and terminates in, the extreme junction boxes. The feed wires are connected to the service supply by means of a 2-wire cable. Both ends of the 3-wire cable are shown to be connected to the service supply with the hot circuit wire open in one of the junction boxes. This divides the circuit somewhat, both circuits being connected to the same 2 phases of the service supply. As this is to be strictly a lighting circuit a No. 14 wire can be used providing the circuit is divided as explained.

According to specifications, at least one lamp of each fixture is to be subject to control from either of two master switches, one located in the hall, the other in the bedroom. This feature is accomplished by the use of the emergency circuit, fed from the same phase of the service supply that feeds the main circuit wires of the lighting circuit. The circuit is through two 3-way or master switches connected to control the emergency circuit.

As all of the fixtures have one socket connected to the emergency circuit through the 3-pole switch of the duplex unit, these lamps will be lighted collectively by the operation of either of the master switches providing all the fixture switches are in the off position. Operation of any particular fixture switch to the on position disconnects the emergency circuit from that fixture. All lamps in the fixture being lighted from the main circuit.

By installing one master switch adjacent to the duplex unit that controls the bedroom lights connection can be made for the feed to the emergency circuit. Likewise the second master switch would be installed next to the hall switch, and connected as shown to the emergency circuit. This would produce a considerable saving in time and material.

Feed to the emergency circuit can be taken direct from the main service supply by running a separate wire from the service to one master switch. This should be fused and connected to the phase that feeds the main lighting circuit. This may be necessary in order to keep the ampere load per circuit within code requirements, should a No. 14 wire be used.

In addition to the porch lights, one at the rear and one at the front, I have shown the base plugs as being wired to the same feed. This circuit, as well as the circuit for the basement lights, is to be connected to the opposite service phase supply from that which feeds the main lighting circuit.

I assume, of course, the service supply from the power company to be 3-wire, 2-ph. If a 2-wire service (from power company) is furnished wiring from the service box is simplified somewhat.

General Comment

Many other entries mentioned points that should be considered or gave helpful suggestions. W. C. Morris, Jr., of Shreveport, La., said:

"The supply for the master switches may be connected to an overcurrent device, connected ahead of the main line switch, or, through an underground master control service entrance conductor to overcurrent device. In either case overcurrent (fuses or circuit breakers) should be concealed and not accessible to prowlers. Master switches should be T rated, 15 amp. minimum. If large loads (over 1650 w.) are to be controlled by master switches, magnetic switches should be used to energize the master panel."

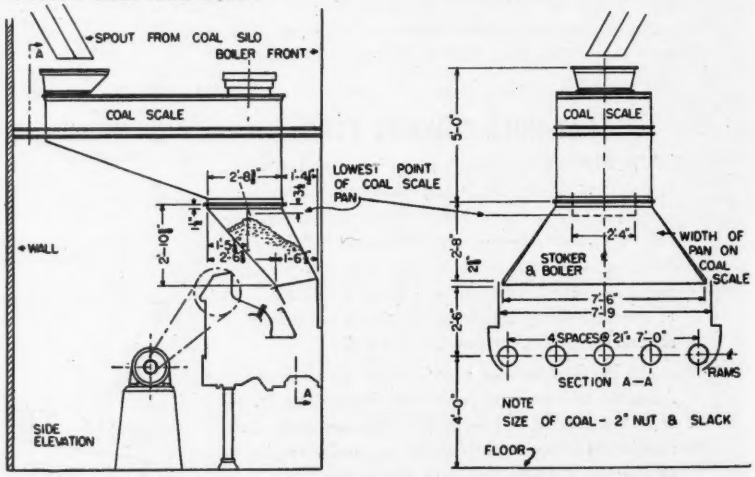
Harold E. Gethoefer of Kenmore, N. Y., suggests that as a convenience to Mrs. Hero "put the fuse box in the kitchen built flush. It is very handy when a fuse blows, not to have to fumble around in a more or less unfamiliar cellar."

Again Robert E. Burlingame of Milwaukee adds: "It is, of course, necessary that the arrangement of wires in conduits be such that both the conductors through which any fixture is fed, with any possible combination of respective positions of the different switches, will be in the same conduit so that current going to a fixture in one wire in a conduit will be balanced by return current from the lamp carried by another wire in the same conduit. To accomplish this the neutral wire, hot wire and master wire should follow identical routes through the various portions of the conduit layout. Also, the wires comprising the complete circuit through the master switches from the hot wire to the master wire should follow a common route through the conduits."

Problem 21
COAL SEGREGATION IN A STOKER HOPPER

Never one to worry overmuch about the future, Our Hero splurged on his honeymoon, thumbed his nose at the Japs and wore about 2000 mi. off his tires treating Mrs. Hero to a bit of Vitamin D on the beach in Florida.

On the way back, however, he stuck his neck out again offering to help a brother engineer in North Carolina solve a coal handling problem—now he's yelling for help in correcting the coal segregation trouble on his friend's 5 retort underfeed stoker.



The layout of the coal handling, weighing and feeding arrangement is shown by the sketch. The outside retorts receive all the coarse coal and the three center retorts all the fines, resulting in a very unsatisfactory furnace condition. Due to limited space special hoppers or vanes ordinarily used to correct this difficulty do not seem practical. Some consideration has been given to the addition of a small screw conveyor, split right and left hand at the center, but this does not seem to offer a real solution. How would you fix this up if it were in your plant?

Write your opinion of this case in a letter of not over 1000 words and send it to the contest editor by March 25. A first prize of $15 will be awarded for the best letter; a second prize of $10 and a third prize of $5. Entries in this problem contest should be addressed to the Contest Editor, Technical Publishing Co., 53 W. Jackson Blvd., Chicago, Ill.

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Today's situation calls for *round-the-clock* production. That means your plant must get *better* service from valves and fittings, and have *better-trained* men to keep piping on the job. Crane Shop Bulletins for maintenance workers are aimed to help you get both. Their wealth of practical pointers aids in guiding new men, as well as assists veteran crews in stepping up efficiency of piping equipment.

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TIPS ON VALVE TRIM
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PLEASE CHECK AND PASS ON
IT'S THE TRIM THAT COUNTS!
HELPFUL HINTS ON CHOOSING VALVES FOR BETTER PIPING SERVICE
HOW TO KEEP YOUR PLANT GOING WITHOUT INTERRUPTION!

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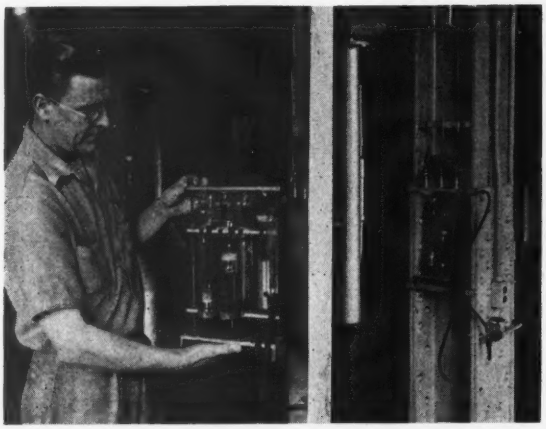
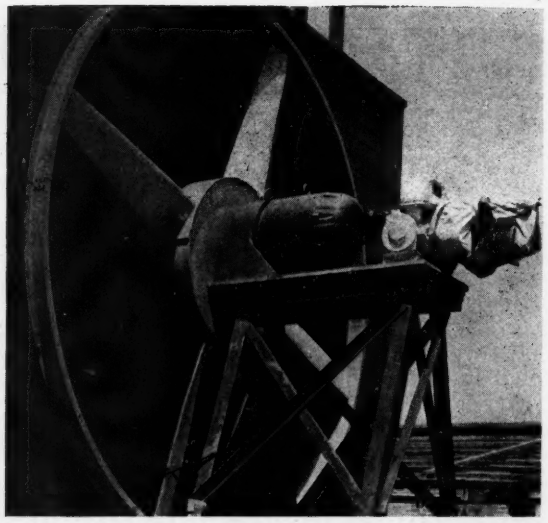
SHOP TALK

A department showing by means of photographs how engineers in various plants have overcome certain obstacles or devised methods to facilitate operation. If you have done something along similar lines that you are proud of or which you feel may be of interest to others, send us a picture and a paragraph of explanation. If the photograph is good and if the idea is original we will present it on this page and pay you for it

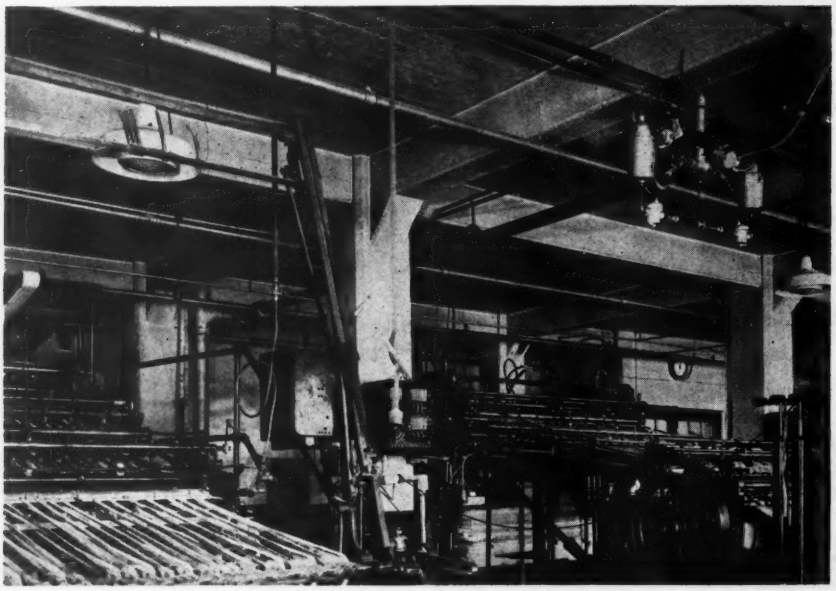


HANDY ORSAT. R. M. Hanson, Results Engineer in the Northern States Power Co., New French Island Station at La Crosse, Wis., believes that test equipment should be convenient. Therefore, he made an orsat in a special frame which fits in the recess of H-section columns as shown. It is located directly under the last pass of the boiler, the gas lines are short and direct and the aspirator is conveniently located on the side of the column. When these photographs were taken the door had not yet been finished. The parts were purchased, the frame was made by Mr. Hanson. The idea is adaptable to a variety of special conditions. A. M. Waldie is Superintendent of the French Island station.



DUAL FAN DRIVE. A southern oil refinery, which recently installed a new 12 cell Foster Wheeler cooling tower, took unusual precautions to insure uninterrupted, economical service and utilize available steam during summer months when heating and process loads are low. Six of the fans have motor drive only, six have dual drive. One of the latter is shown by the photograph. The turbine drives through the motor but an automatic clutch permits the motor to run without dragging the turbine. Fan blades are bolted to flat bases on the hub and the pitch may be changed to vary the capacity, and the power consumption.

BULLETIN BOARD. A movable bulletin board, says Leslie Bradley of Bismarck, S. D., has many uses: notices; safety bulletins; lost time accidents, etc. Note the second board in the background made with pegs to hold circular charts taken from recording instruments and various meters.



STATIC. Static electricity bothers lots of people besides radio fans. It was particularly bad in the press room of the Nazarene Publishing Co., Kansas City, Mo. Printing operations were slowed up, dust and lint stuck to the presses and the sheets would not pile up evenly. Water sprays the entire length of the room were not very practical, relative humidity could not be carried above 20 per cent, pools of water collected and the winter heating load was excessive. Recently they installed two Armstrong humidifiers as shown in the photograph. Low-pressure steam was not available so a 3-hp. gas fired boiler was installed at the same time. Experience shows that best results are obtained with a relative humidity of about 40 per cent and a temperature of about 72.

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The aim of municipal lighting plants and public utility companies is to manufacture electricity at the lowest possible cost. They have found that one of the greatest cost savers is automatic combustion control. Many have found also that HAYS centralized control is simple to install, understand and maintain. A few of these are illustrated. What is good for the utilities is good for your power plant: cost saving is a necessity with any steam generating plant. Write for further data.
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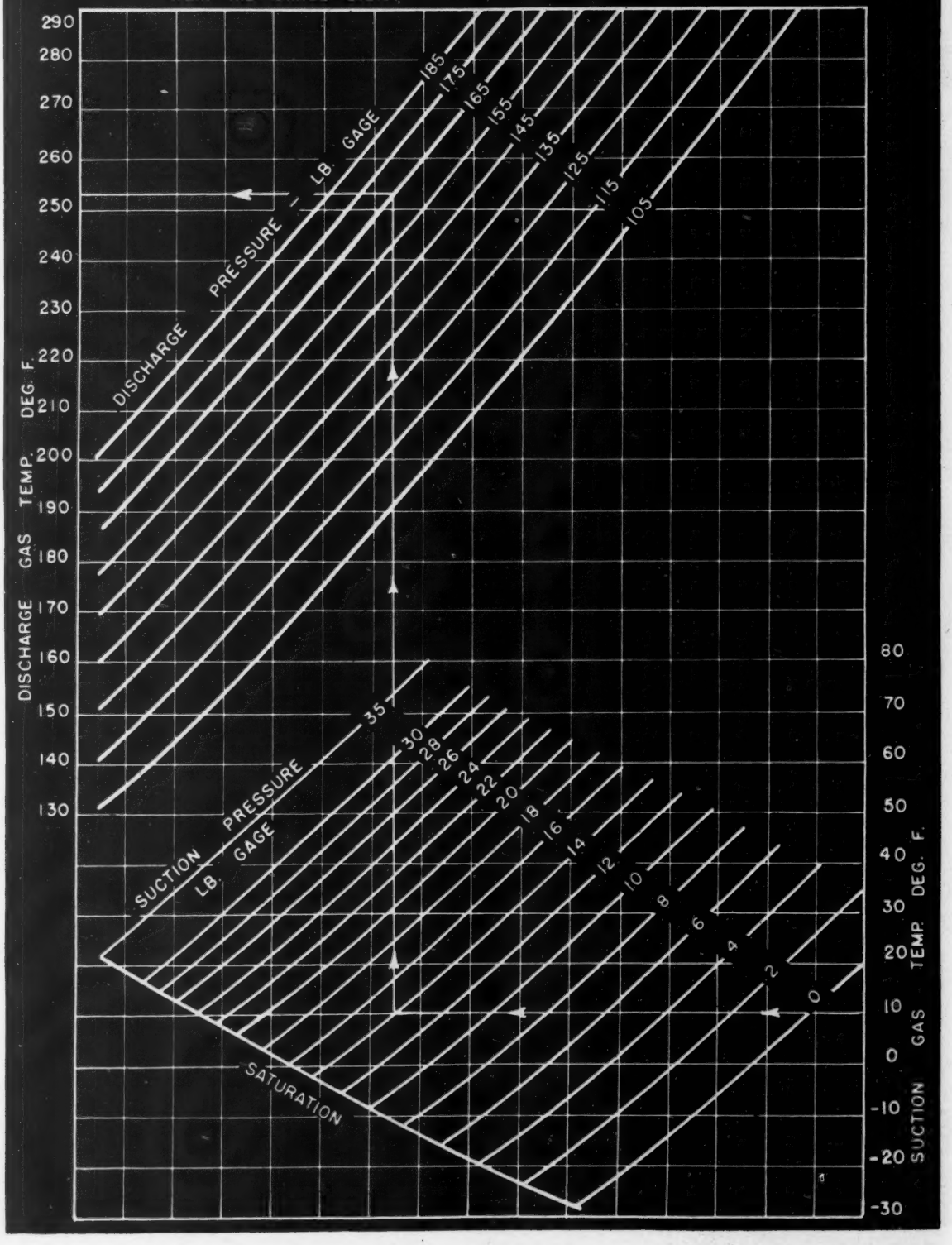
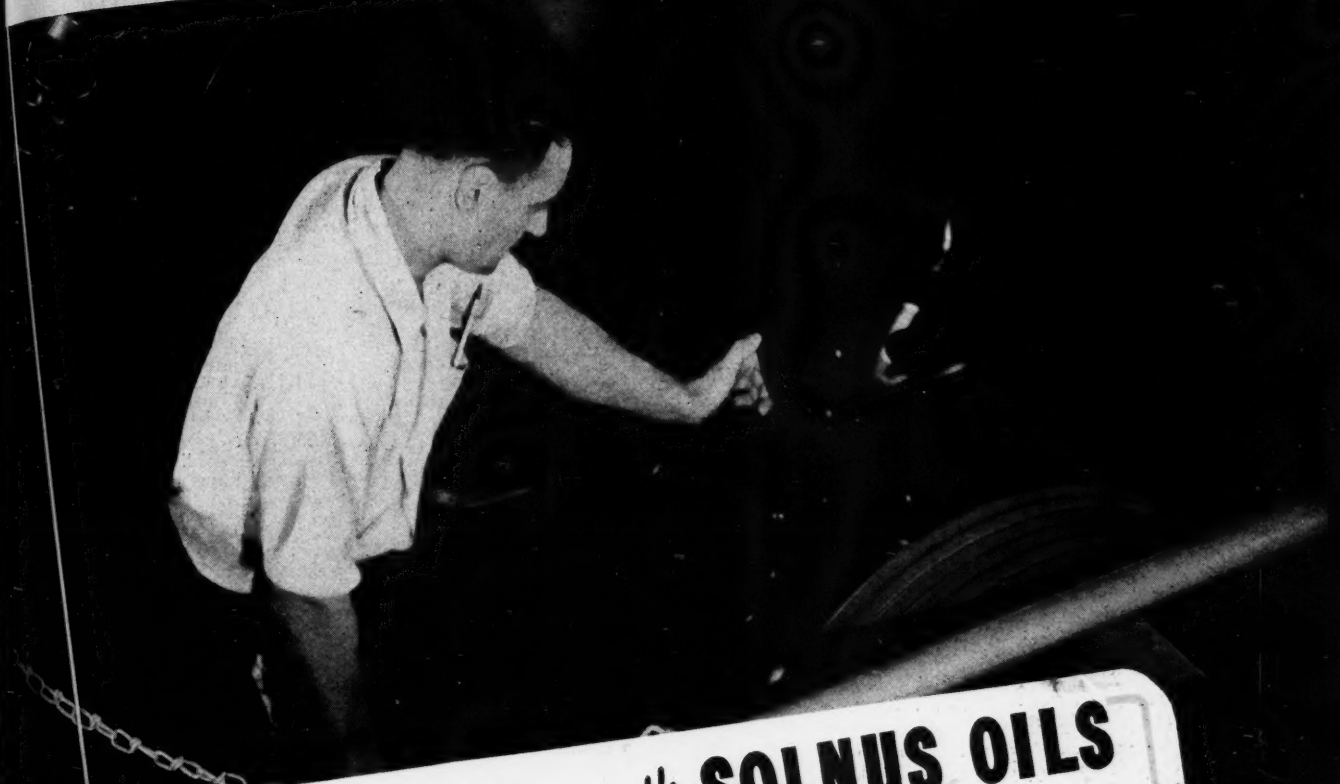
THEORETICAL GAS DISCHARGE TEMPERATURES FOR AMMONIA COMPRESSORS

Calculated for Adiabatic Compression by F. B. Gilbert, Mechanical Engineer of The Creamery Package Manufacturing Co., Chicago, Ill., from the United States Bureau of Standards Ammonia Tables



own goes "Down-Time"-66%



1000 EXTRA HOURS BETWEEN SHUTDOWNS *with* SOLNUS OILS

"Down-time" is lost time. Reduce "down-time" and you save that most vital of war-time needs—power!

Here's a diesel owner who cut "down-time" two-thirds—actually eliminated two out of every three shutdowns for inspection and carbon cleaning—by changing to SOLNUS OILS for diesel lubrication. His former trouble of piston rings breaking has entirely vanished . . . and engine maintenance costs have dropped sharply.

Add your plant to the many that are already getting peak diesel performance . . . and stepped-up production . . . by using SOLNUS OILS, the modern diesel oils that are

- **Wholly Distilled**
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LET'S GO! U.S.A. KEEP 'EM FLYING!

SUNOCO

SUN PETROLEUM PRODUCTS HELPING INDUSTRY HELP AMERICA

WAR NEWS FROM THE INDUSTRIAL FRONT

(Continued from Page 84)

New Orleans. At East Coast ports the price north from Norfolk to Portland is $1.35 and from Norfolk south to Jacksonville, $1.30.

Chlorine for Water Treatment

CHLORINE is one of the most widely used chemicals in war manufacture, and quantities necessary for water purification will be provided despite the general chlorine shortage, the Chemicals and Allied Products Branch of WPB announced.

High test calcium hypochlorite and chloride of lime are at present more scarce than chlorine and sodium hypochlorite and for that reason it may be necessary that those plants which use these materials change to one of the latter. It was pointed out that this will not impair sterilization efficiency, as chlorine, sodium hypochlorite, chloride of lime, and high test calcium hypochlorite can be used interchangeably for that purpose.

Wire and Cable Prices Fixed

BECAUSE electrical wire and cable, essential to the country's war program and civilian economy through communication and power distribution systems, have increased from 5 to 25 per cent since Jan. 1, 1941, formal price ceilings were established at the October 15, 1941, level by OPA Price Schedule No. 82, issued Jan. 30.

This schedule sets maximum changes for drawing wire or rolling bars; raises the maximum price for weatherproof wire to 17.5 ct. per lb.; and provides for price adjustments for deliveries more than 9 mo. after the date of contract.

WPB Absorbs OPM Duties

ONE WEEK after the President's order creating the War Production Board, the chairman, Donald Nelson, outlined the organization through which the board will work. Besides absorbing and centralizing the former functions of OPM the new organization adds a number of new branches to assist, and correlate the efforts of the working committees. As now set up war production is centered in six divisions, to which a seventh will probably be added in the near future.

The function of the new Division of Industry Operations will be primarily to convert industry as quickly and smoothly as possible to war production. It will deal primarily with conversion of entire industries, as for instance the automobile and washing machine industries. Basic commodity groups such as copper, lead and zinc will come under the Materials Div. as before. Other authority delegated to the Director of Industrial Operations includes the power to issue priority orders and regulations, compel acceptance of war orders; requisition property of persons or firms and approve requisitions of other federal agencies.

Consolidation of all field activities of the War Production Board in a new Bureau of Field Operations under the Division of Industry Operations was announced February 5. Merged under the new set-up are the 45 field offices hitherto maintained by the Priorities Division and the 113 offices operated by the former Division of Contract Distribution. Steps will be taken to coordinate any other field activities of the War Production Board within the framework of the new bureau. Existing field offices are instructed to continue their present activities without any interruption whatever and in so far as possible it is expected that existing staff and personnel in the field will be retained.

1000 Fire Pumps a Day

THE FIRE PUMP industry will be able to meet the requirements for thousands of new fire-fighting pumps, it was announced by George Angell, chief of the fire equipment and safety section of the WPB. In addition, he said, the industry will be able to use substitute materials for some of the critical items now being used in such pumps.

Industry representatives, comprising an industry advisory committee, advised the WPB representatives that with some additional tooling it will be possible for them to increase production to at least 100 per day of pumps with a capacity of 500 gallons per minute and suitable for front mounting on fire engines. About 30 such pumps are now produced daily.

Blackout vs. Air Raid Warning

IN ORDER to prevent misunderstandings regarding blackouts and air raid warnings and the relation between them, the Protection Division of OCD has released the following definitions:

A blackout is a precautionary darkening of lights which might aid hostile aircraft in locating particular targets. Under a blackout it is expected that all normal activities will continue except those which mean showing lights. A blackout does not necessarily mean that there are enemy aircraft in the vicinity. Blackouts are precautionary measures.

On the other hand, an air raid warning means there are hostile or unidentified planes close by. It means that normal activities must be modified to get people under shelter and preparations made for casualties and other damages as the result of the dropping of bombs, should that take place, within a few minutes. Air raid warnings are protective. All air raid warnings at night include blacking out, of course; they likewise include the alerting of the various elements of the Citizens' Defense Corps.

More Power for Milwaukee

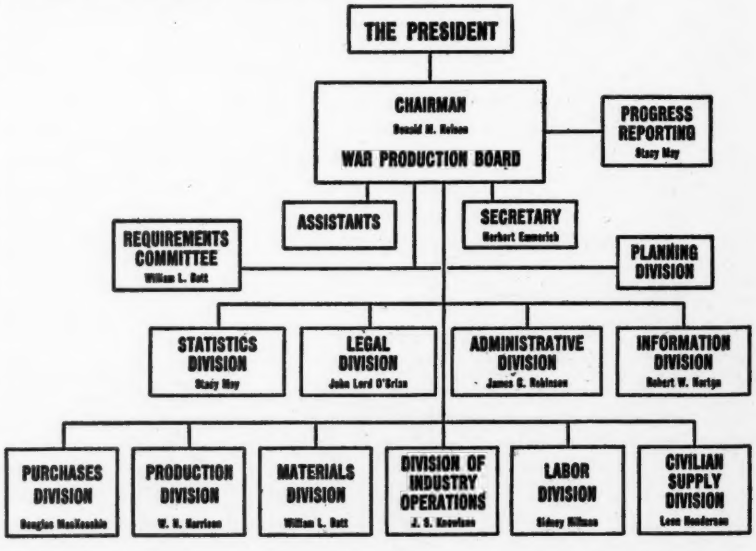
ON THE LAST day of 1941 the Wisconsin Electric Power Co. put a new, 35,000 kw. Allis-Chalmers unit into service in its Commerce Street plant in Milwaukee. The unit is part of a $4,137,000 plant addition and will raise the installed capacity of the company's system to 483,700 kw., 80,000 of which is in the company's world famous Port Washington Station. Due to the armament program many Milwaukee industries expect to double their power consumption before mid-year.

Petroleum Industry Meets Odd Demands

SUPER-FUELS for airplanes claim attention as the petroleum industry gets into stride for war, but at the same time hundreds of little-known and unsung petroleum products are meeting war demands. Petroleum refineries are now gigantic chemical factories which utilize crude oil as the raw material from which to manufacture tailor-made and essential commodities in remarkable variety and volume.

One of these is the case of lubricants for the bearings and surfaces of submarine fins where no ordinary grease can be used because it leaves oil spots on the water to form a clear trail for enemies. The petroleum industry has developed a special grease which leaves no "slick" when the underseas craft submerge. Again industry is making wool oil, used in the manufacture of uniforms to lubricate the fibres during the yarn-spinning process and thereby to increase tensile strength and expedite production.

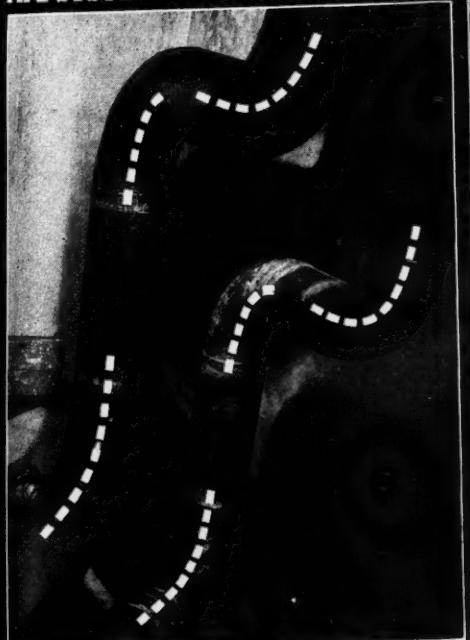
Camouflage of field equipment calls for lacquers and lacquers call for aromatic solvents, being supplied by the industry in growing quantities. These aromatic solvents obtained from petroleum are going into the production of toluol, now definitely a petroleum product, for it is made there more rapidly, more cheaply, and more easily than from any other source.



...Taking the curves FAST is equally treacherous in piping!

THE DANGER LIES AT THE TURNS

TUBE-TURN FITTINGS MAKE EVERY PIPE SYSTEM STRONGER AND SAFER



When pipe lines snake their way thru a plant like these chemical lines, forming neat, compact layouts, it's little wonder engineers insist on TUBE-TURN fittings. There are no flanges to tighten, no gaskets to replace—no chance of dangerous leakage. The turns indicated above *—where the danger lies*—are strong and safe—fully protected with TUBE-TURN welding fittings.

There's less flow resistance and pressure loss when you use Tube-Turn welding fittings

A flashing glide down the mountain side into a splendidly executed *Kristiana*—a sweeping turn at full speed that scarcely slows the skier! It's the same kind of uninterrupted flow that engineers desire in piping—and TUBE-TURN welding elbows and returns assure minimum resistance, thanks to the easy sweeping radius throughout. TUBE-TURN fittings' smooth inner walls are free from waves, scales or ridges which often accelerate corrosion and erosion. TUBE-TURN fittings give *plus strength* where the danger lies—at the turns—wherever there is a change *in flow direction!* For safe, trouble-free piping systems, insist on TUBE-TURN welding fittings!

Write today for TUBE-TURN engineering data book and catalog.

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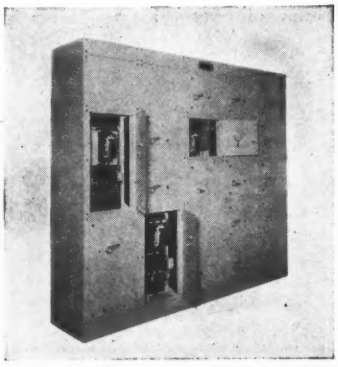
Welding Fittings

New Equipment

Information that you desire about any equipment will be gladly furnished without obligation. WRITE POWER PLANT ENGINEERING.

Motor Control Center

FOR GROUP CONTROL of a.c. motors up to 100 hp. for industrial use, a new control center with interchangeable units has been announced by Westinghouse Elec. & Mfg. Co. Available in 76 and 90-in. heights, the centers consist of a 7-in. filler at the top for horizontal buses and cable trough, a 5-in. filler at bottom for cross cable duct, an 8-in. filler for master terminal boards, and multiples of the basic 14-in. starter unit heights.



Interchangeable units are trim mounted 20 in. wide, permitting two to five control elements to be placed in a single section. Sections are 20 in. deep allowing sufficient depth to mount the units on each face, i.e., back to back if desired.

For operation on 3-phase, 220, 440 and 550 v. circuits, the motor starter units consist of a full voltage magnetic starter providing external manual reset, thermal overload, and low voltage protection. The disconnect switches may be unfused, quick-make and quick-break, of the circuit breaker type with thermal inverse time overload and instantaneous short circuit protection. A fused disconnect switch is available up to 7.5 hp., 220 v. or 15 hp., 440 v. The entire control center is finished in black lacquer and assembled ready to receive line, motor and control circuit connections.

Drying Agent for Gases and Liquids

FLORITE Desiccant, a new granular drying agent for gases and liquids, has recently been placed on the market by the Floridin Co., Warren, Pa. Florite Desiccant has been employed in a variety of industrial processes requiring bone dry gases and liquids and also where high drying efficiency is not ordinarily demanded. Among the products now being successfully dehydrated are natural gas, propane, gasoline, air, nitrogen, and carbon dioxide. It may also be used in breathers for storage tanks and electrical transformers, to dehumidify air in air conditioning systems and to dehydrate refrigerants. Florite Desiccant is hard, stable, non-corrosive and non-poisonous. It selectively adsorbs 4 to 20 per cent of its weight in water, depending on the particular application, and is regenerated by heating to 300-350 deg. F.

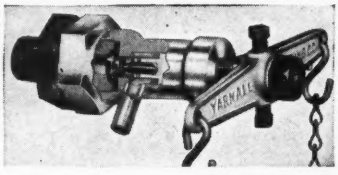
Identification Buttons

A NEW, tamperproof photographic identification button, manufactured by Parisian Novelty Co., Chicago, Ill., is now being used by many of the nation's leading industrial firms for identifying plant and office employes.

The buttons are washable, durable, unbreakable and tamperproof. Each button is over 2 in. in diameter, and contains a good sized photo of the worker by whom it is worn. Guards and watchmen can thus more efficiently discharge their duty in the apprehension of imposters. Servicemen, truck drivers, messengers and others wearing the identification button and whose work takes them into plants working on defense jobs can more easily gain admittance, and fraudulent impersonation of such individuals is effectually prevented.

Water Column Try-Cocks

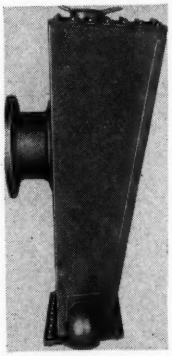
THE NEW Yarway Heavy-duty Try-cock, manufactured by Yarnall-Waring Co., Philadelphia, Pa., is built for modern high-pressure service. Try-cocks are easy to operate and they shut off tight—no dripping. For pressures up to 600 lb., body and stem are tobin bronze; for 600



to 1500 lb., these parts are stainless steel. Shanks are stainless steel. Needle valve and seat are stainless steel, heat-treated; these parts reversible and renewable. To avoid interference of operating chains, the operating lever on upper try-cock is offset outward, lever on center try-cock is straight and lever on lower try-cock is off-set inward. The try-cocks are also made in weighted lever style with single operating chains.

Foam Mixing Chamber

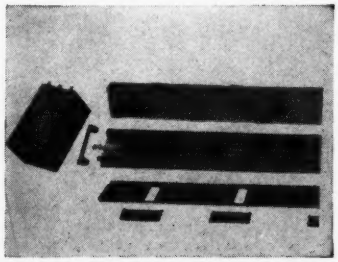
TO PROVIDE a simple, yet effective method of applying a blanket of fire-smothering foam to burning oil surfaces, American-LaFrance-Foamite Corp., Elmira, N. Y., has placed on the market the "Evertite" mixing chamber. It derives its name "Evertite" from the fact that an inspection cap can be removed, and a sealing diaphragm inspected, without releasing tank pressure. A separate adapter flange is provided for mounting over foam opening in oil tank shell.



The vapor-proof glass diaphragm is so installed as to prevent vapors in oil storage tanks from entering the body of the mixing chamber, from entering and condensing in chemical solution lines, or from escaping to the air when bottom or top plate, or inspection cap, are removed. The diaphragm, glazed in a metal frame, holds gas tank pressure, yet ruptures fully under foam pressure at time of fire, allowing free access of foam blanket to burning surface. Diaphragms are readily replaced. Frame may be unbolted, and removed to work bench for new glass, or extra complete diaphragms may be carried in stock, ready for immediate installation.

Bus Duct

FOR INDUSTRIAL secondary power distribution systems, a new bus duct is announced by Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa. Units are of the plug-in and feeder types. Composed of copper busses, Prestite separators, and a dust-tight metal enclosure, the unit is available in ratings of from 250 through 1500 amp. At currents below 1500 amp., long life, hot rolled sheet steel is used;



at values of 1500 amp. or above, a feeder duct of different construction is available.

Plug-in sections are supplied in 10-ft. line units with outlet service staggered every 12 in. along a run. Outlet receptacle covers are not removed but simply slide

LUNKENHEIMER VALVES

Are Helping to Build Battleships

ESTABLISHED 1862
THE LUNKENHEIMER CO.
"QUALITY"
CINCINNATI, OHIO, U. S. A.
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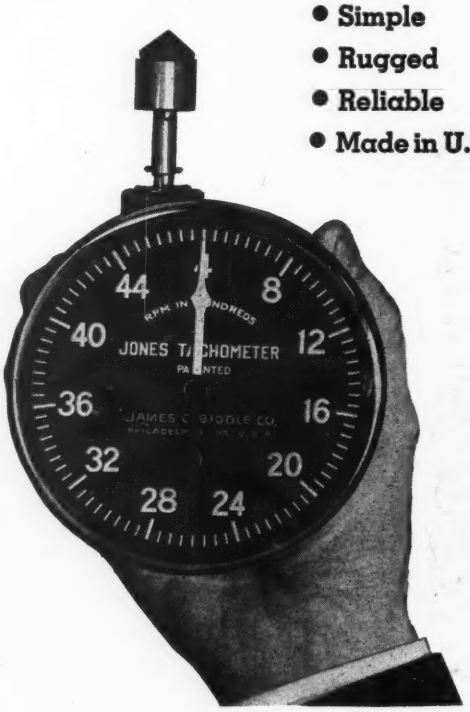
Your Lunkenheimer distributor has a supply. Ask for your copy.

The JONES HEAVY DUTY HAND TACHOMETER

- Simple
- Rugged
- Reliable
- Made in U.S.A.



HERE is a rugged American-built Hand Tachometer . . . available for reasonably prompt delivery, depending on priority ratings.

We recommend the Jones Heavy Duty Hand Tachometer for indicating rpm and surface speeds of all types of machinery in which the moving parts are readily accessible.* It is built to "stand the gaff" and maintain good accuracy in every-day hard service. Single and triple range models up to 12,000 rpm.

Write for new descriptive Bulletin 1710-PE.

*Where moving parts are not readily accessible, as in turbines, centrifugal pumps and other totally enclosed machines, and also for measuring vibrations per minute, we recommend our Frahm Vibrating-Reed Tachometers. Ask for Bulletin 1590-PE.

James G. Biddle Co.

1211-13 ARCH STREET *Electrical and Scientific Instruments* PHILADELPHIA, PA.

along duct to expose plug-in connections. Heavy silver plating of contact areas at bus bar joints assures good contact. Insulators are of Prestite insuring maximum mechanical strength. Complete insulation of plug-in receptacles aids safety by preventing flash-over in making or breaking plug-in contacts.

To install, the bus duct is hung by narrow double-strap hangers either edgewise or flatwise, depending on availability of plug-in. Where suspension rods are used, fastening is made to any convenient overhead suspension point and an adjustable cantilever clamp slides along the duct to the point of alignment.

Safety Seals

INDUSTRY has a new ally for sabotage prevention in a tamper-proof safety and inspection seal that also allows for secret identification markings.

These new Stoffel Seals, manufactured by Stoffel Seals Co., Inc., New York City, guard against tampering, alteration or substitution, and are made of two components: the pre-shaped metal seal-cup and the individualized identification disc, multi-color printed.

In addition to carrying complete identification information, basic colors serve as instant indicators of, for instance: time element, process, location or priority of sealed object. Further markings, such as inspector's number, department number, can be incorporated in sealing pliers, so that at moment of closing pliers, this number or mark is indented into identification disc.

Seals can be permanently applied with either string, thin cord or 2-ply wire, whichever is most suitable to the sealing operation with the lightweight pliers. Once these two component parts are locked, the seal cannot be tampered with without immediate visual detection, for once removed they cannot possibly be used again.

Organic Colloid

ANNOUNCEMENT of the introduction of Tanaliginate—new protective and reactive colloidal material to supplement simple chemicals in the correct conditioning of boiler feedwater has been made by The Bird-Archer Co., New York, N. Y. This new product is used in conjunction with such inorganic chemicals as phosphates or alkalis, and when used under competent supervision and control, the results obtained are said to be far beyond the limitations of inorganic chemicals alone.

☆

AN ARMY, NOT IN KHAKI OR BLUE

. . . but on the march for you!

From coast to coast Morse dealers, distributors and sales engineers are attacking power transmission problems to keep your production up to war needs. No task is too great or small for this army of front line power veterans. They are trained power specialists, tried and practical—working to fulfill your demands. All are backed up by the vastly expanded Morse engineering and production facilities. ¶ For sound counsel and rapid solution of power transmission problems call on these men.

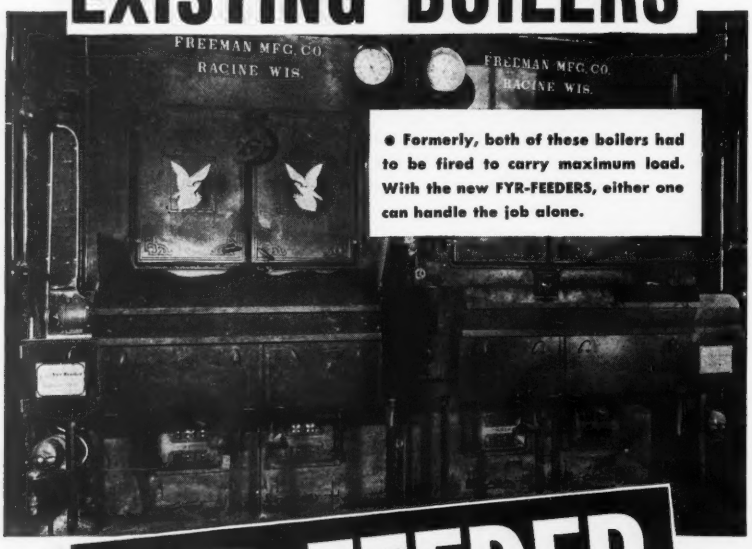
SILENT CHAINS ROLLER CHAINS FLEXIBLE COUPLINGS

MORSE *positive* DRIVES

MORSE CHAIN COMPANY ITHACA N. Y. DIVISION BORG-WARNER CORP.

The Solution for One of Industry's Biggest Problems:

MODERN FIRING FOR EXISTING BOILERS


FREEMAN MFG. CO.
RACINE WIS.
FREEMAN MFG. CO.
RACINE WIS.
● Formerly, both of these boilers had to be fired to carry maximum load. With the new FYR-FEEDERS, either one can handle the job alone.

FYR-FEEDER

RISING TIDE OF ACCEPTANCE: FYR-FEEDER "Multi-feed" Spreader Stoker sales in 1941 showed an increase of 67% over 1940—due in large part to FYR-FEEDER'S ability to increase the capacity of many existing boilers.

64% FOR MODERNIZATION! 18% of 1941 FYR-FEEDER sales replaced underfeed stoker firing; 18% replaced overfeed stoker firing; 28% replaced oil burning furnaces, hand-fired grates, or pulverized coal. These installations consistently resulted in lower fuel costs . . . increased capacity . . . lower maintenance costs.

MANY REPEAT ORDERS! Nearly 37% of all FYR-FEEDER sales in 1941 were repeat orders — best proof of users' satisfaction.

DELIVERY. Quick delivery of FYR-FEEDER Spreader Stokers is assured for industrial plants working on Defense contracts . . . plants producing essential civilian goods . . . food processing plants . . . institutions and schools . . . mines . . . utility plants . . . railroad steam plants . . . or plants otherwise qualified to obtain priority ratings. For complete details use the coupon below.

TERRITORIES FOR SALES ENGINEERS
Some territories are open for experienced sales engineers familiar with steam plant boilers and furnaces. Information on request. Please furnish record of your experience and references.

AMERICAN COAL BURNER COMPANY

FOUNDED 1918

Builders of thousands of Industrial stokers

AMERICAN COAL BURNER COMPANY, *ENGINEERS*
22-18 East Erie St., Chicago, Ill.

☐ YES, I want to know what the FYR-FEEDER can do in our plant.
☐ Please mail descriptive literature.
☐ I am interested in selling FYR-FEEDERS.

Name .....
Company .....
Address .....

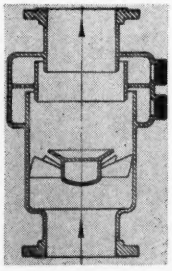
You Can See the Superiority
AIR FROM NOZZLES:
1. SPREADS COAL
2. PROVIDES AIR FOR COMBUSTION
3. CREATES TURBULENCE IN COMBUSTION CHAMBER
MULTIPLE SCREW FEEDERS 12" APART
TWO FIRES: FINES BURN IN SUSPENSION. LARGER COAL ON GRATE.
COAL
AIR IN TO INDIVIDUAL BURNERS
UNDER GRATE AIR

Each FYR-FEEDER has 2, or 4, or more burner spreaders giving dependability and convenience in cleaning grates, impossible to secure with a single spreader. MULTIPLE BURNER SPREADERS ARE A VERY WORTHWHILE ADVANTAGE.

Line Purifier

To REMOVE OIL from exhaust steam, dry and clean steam for engines, remove dirt, oil and water from compressed air and remove entrainment from gases and vapor, the Centrifix Corp., Cleveland, Ohio, has developed and recently improved the Centrifix Line Purifier.

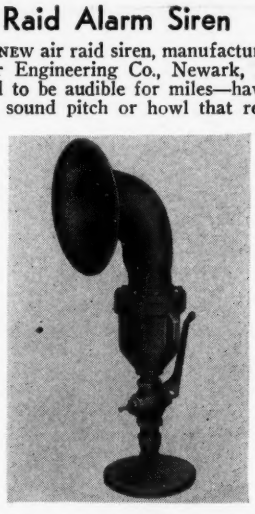
In operation, the vapor enters this new purifier and as it passes through the stationary radial tuyere, the vapor and entrainment is given a whirling ac



tion that centrifugally throws the entrainment to inner walls of purifier. The forward motion of vapor along with its spiral action continually wipes this entrainment towards the annular slots leading into the two eject races. In this device the entrainment has no chance of re-entering the vapor stream after it is once thrown out to the inner walls. Very little obstruction is presented to the vapor stream and hence any friction is at a minimum.

Air Raid Alarm Siren

A NEW air raid siren, manufactured by Foster Engineering Co., Newark, N. J., is said to be audible for miles—having a rising sound pitch or howl that reaches



its maximum tone in from 3 to 5 sec. It is well adapted for signaling because of a sharp sound cut-off. Operates on steam or air at 50 to 250 lb. pressure, 425 deg. F. total temperature. All bronze or steel and bronze construction.

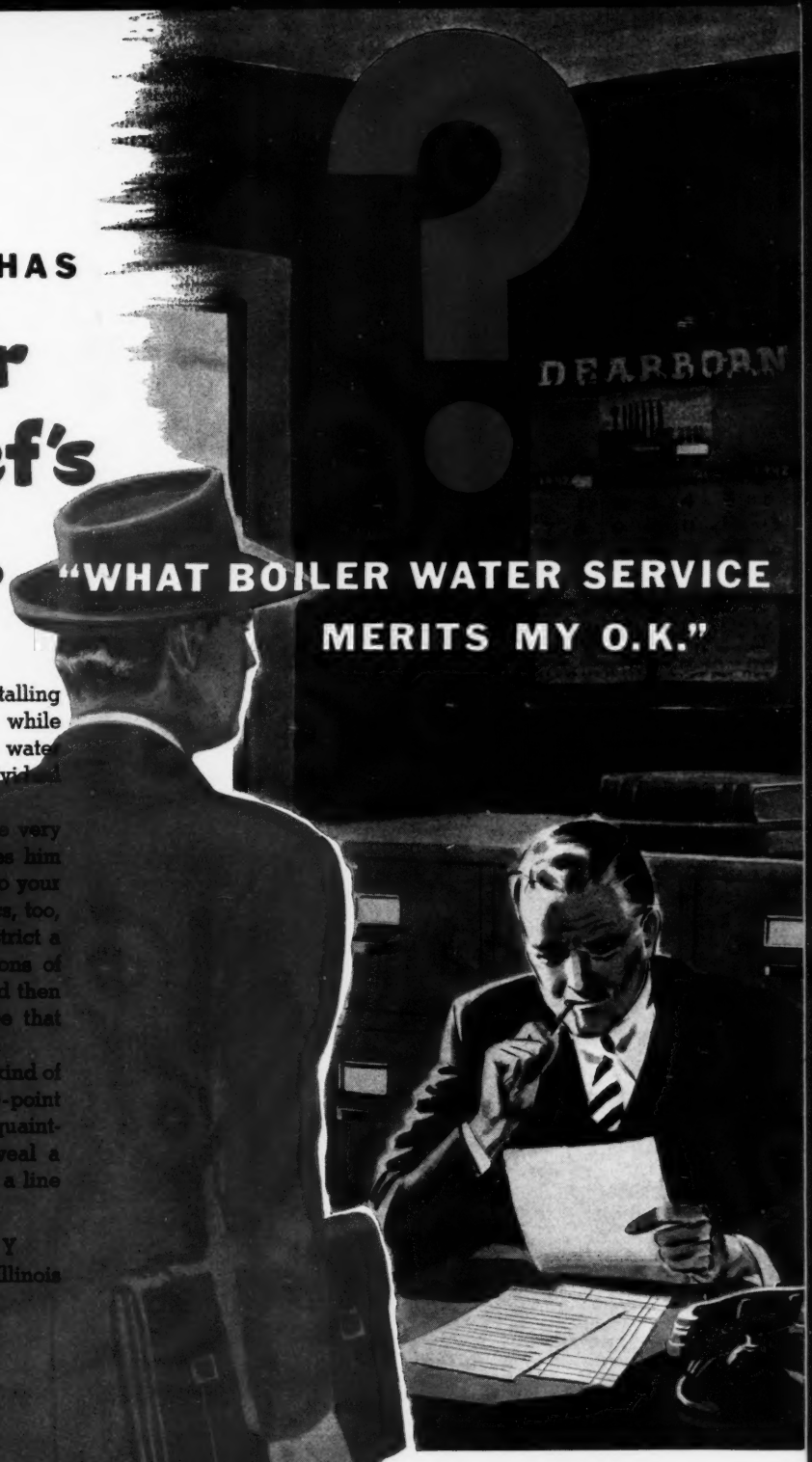
Electrical Insulation

IRVINGTON Varnish & Insulator Co., Irvington, N. J., announced recently their new Fibronized Koroseal Tubing designed for use as electrical insulation by manufacturers in the electronic, instruments, aircraft, electrical appliances and power industries.

The advantages of the tubing are said to include inside and outside smoothness, exceptional elasticity and close manufacturing tolerances. Has excellent resist-

DEARBORN ENGINEER HAS

the answer to the Chief's Question..



"WHAT BOILER WATER SERVICE MERITS MY O.K."

Doping the water is not the answer. Installing equipment for feeding chemical treatment, while important, is not the answer either. Boiler water treatment service has to be much more individual and scientific than that.

Dearborn Engineer recognizes that from the very start. But his accumulated experience enables him to come up quickly with the correct answer to your problem. He knows local water characteristics, too, because he has worked and lived in his district a long time. He studies the operating conditions of your plant, recommends correct treatment, and then keeps in contact with you periodically to see that full efficiency is maintained.

Power plant engineers lean heavily on that kind of scientific service . . . a thoroughly grounded 6-point service. Over 8000 power plants use it. Acquaintance with the Dearborn Engineer will reveal a service which fully merits *your* O.K. Drop us a line . . . we'll arrange for him to see you.

DEARBORN CHEMICAL COMPANY
Dept. F, 310 S. Michigan Avenue, Chicago, Illinois

Dearborn Engineer does this for you . . .

(1) *Studies* your water and plant operating conditions.
(2) *Sends* samples of your water to main laboratory for analysis.
(3) *Recommends* proper chemical treatment and chemical control methods.
(4) *Supervises* installation of feeding equipment.
(5) *Instructs* your men on water test methods for treatment dosage adjustment and blow-down control.
(6) *Calls* regularly to insure maintenance of recommended conditions.

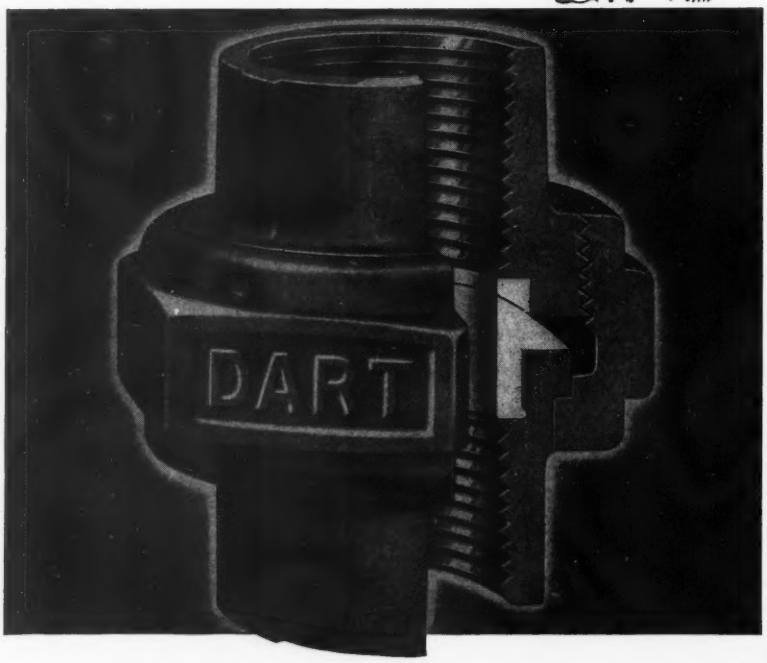
Dearborn

WATER TREATMENT AND ENGINEERING SERVICE

LOOK

for the DARTS

you thought were through



and PUT THEM BACK TO WORK

The extra-value of Dart Unions has never been more fully realized than today—when the conservation of metal is so necessary. In fact, we are recommending to plants all over the country, that they make a search to locate used and discarded Dart Unions, so that they can be *put back on the job.*

You see, Dart Unions are engineered and made to be used again, again and again . . . providing "first-time" tightness each time they are installed. Matched bronze seats, ground to accurate "true-ball" surfaces is one important reason why Dart Unions can do this. *Another* reason is that Dart Bodies and Nuts are made of air refined malleable iron that resists pipe strains, rust and rough handling.

So, we suggest again: in the interest of metal conservation, search plant and pipe scrap-pile for *old* Darts; see your *supplier* for new Darts. Old or new a Dart comes through.

DART UNIONS

E. M. DART MFG. CO. Providence, R. I.

Sales Agents: The Fairbanks Company New York, and all branches
Canadian Factory: Dart Union Company, Ltd., Toronto, Canada

ance to acids, alkalis, solvents and heat. Is fireproof and possesses an insulation resistance of affinity after 16 hr. at 90 per cent R.H. and 105 deg. F. Has a tensile strength of 2845 lb. psi., a dry dielectric strength (0.022 in. wall thickness) of 1050 v.p.m., a wet dielectric strength (0.022 in. wall thickness) of 817 v.p.m. after 24 hr. immersion.

New Industrial Acousti-Booth

To CONSERVE steel for national defense, the Burgess Battery Co. Acoustic Division, Chicago, Ill., has developed a new line of Acousti-Booths, constructed of heavy reinforced birch plywood, specifically designed for industrial use.

The walls and ceiling of this new booth consist of perforated, reinforced panels, which are filled with a thick blanket of sound-absorbent material. The perforated acoustic panels blot up stray noise and create a remarkable "zone of quiet" in the booth.

The booth provides a quiet place for telephone users in factories, power houses, or other noisy industrial locations. The doorless Acousti-Booth has a shelf provided for the telephone instrument and for taking notes. Overhead electric light fixture with pull-chain provides ample illumination. Outside dimensions are 30 in. wide, by 79½ in. high, by 38 in. deep.

Floor Treatment Unit

COLORFLEX-PLUS, manufactured by Flexrock Co., Philadelphia, Pa., a complete unit, that consists of a cleaner and dye-like coloring that cleans and conditions floors by removing dirt, grime, and grease—neutralizes the excess alkalinity in concrete, thus enabling the dye-like coloring to form a perfect affinity with the floor.

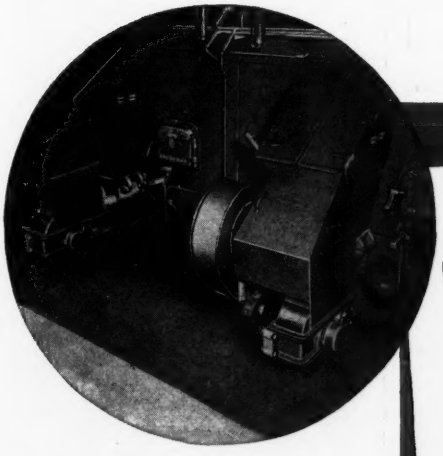
Easy to apply, Colorflex-Plus is said to convert dull, dingy, drab floors into attractive, sealed, dust-proof surfaces. Floors can be attractively colored without muss or fuss or extra labor. Large floor areas can be covered quickly and are said to dry fast to a rich-looking scuff-proof finish.

Paint Stripping Unit

SPECIALLY designed for use with the Oakite Hot Flow-On Method for removing many types of paint, lacquer and enamel from transformer radiators before repainting, the Oakite Oil-Heated Paint

CANTON STOKER *Engineering saves*

174 tons of coal..



Above are shown two of the three Canton Stokers that are on the job saving coal (and money) for famous Grove Park Inn at Asheville, North Carolina.

After a careful survey of Grove Park Inn requirements was made by Canton Stoker Engineers, one Worm-feed and two Ram-feed units were installed. These Canton Stokers replaced firing equipment of another make. Immediately, coal consumption dropped from 492 tons to 318 tons—a 174-ton savings!

Perhaps the same money-saving opportunity exists in your steam plant. Our Engineers are offering timely suggestions to many vital industries, suggesting changes that increase capacity and efficiency and reduce fuel bills.

Your request for helpful literature or personal consultation will receive our prompt attention. Write, wire or phone today.

Below is shown cross-section of a Canton Stoker in operation showing method of feeding and burning coal.

January 1st,
1940

Mr. H. S. Fulford
District Representative,
Canton Stoker Corporation
Canton, Ohio

Dear Sir:

We submit at your request the following data as to our fuel consumption during the months of October, November and December, following the installation of your stokers as compared with the same months as last year.

1937		1938	
Oct.	146 tons	Oct.	148 tons
Nov.	163 "	Nov.	144 "
Dec.	183 "	Dec.	163 "

1939	
Oct.	78 tons
Nov.	119 "
Dec.	121 "

The above figures are taken from the daily record and the reduction shown is attributed to various changes which we made in our heating plant. One of the most contributing factors, I believe to be, is the electric driven Canton Stokers installed. We have three of these stokers, one worm type, operating on our vertical 40 H.P. boiler, and two ram type operating respectively 2 H.R.T., 125 H.P. boilers.

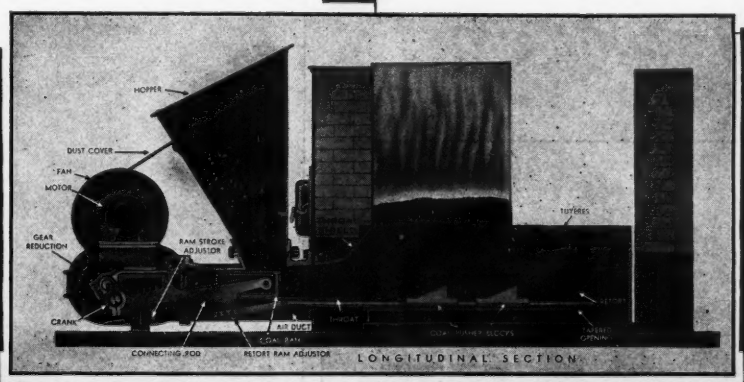
The two ram type stokers are equipped with zone wind boxes and inside dump grates which adds much to our efficiency and greatly reduces the smoke and flyash problems.

Yours very truly,

GROVE PARK INN

J. P. Roberts
Engineer

JPR
IMB



CANTON STOKER

CANTON STOKER CORPORATION

ANDREW PLACE, S. W., CANTON, OHIO

Below, a reproduction from an actual unretouched color photograph which illustrates the appearance of the gauge glass from directly in front.

"...and be sure they're PYREX"

That's a "must" order from the engineer who has eye-witness evidence of the performance of PYREX Broad Red Line Gauge Glasses.

The one job of a gauge glass is to show water-level—and that's the job PYREX Broad Red Line Gauge Glasses do better than all others.

Look at the illustration at the left. The broad red line fused directly to the wall of the gauge glass *makes* the liquid level stand out. The resistance of PYREX brand Gauge Glasses to the corrosive action of steam insures a long life for that liquid level visibility.

Those qualities, plus machine-drawn accuracy, ability to withstand maximum working pressures, and remarkable resistance to thermal shock make PYREX brand Gauge Glasses the first choice of good engineers. Stocked by leading mill and steam supply dealers.

"PYREX" is a registered trade-mark and indicates manufacture by Corning Glass Works.

CORNING Glass Works Corning, New York

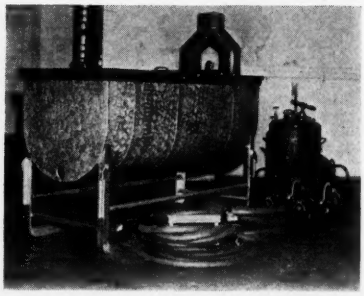
Pyrex Gauge Glasses

Change of Address

To avoid missing an issue or paying for forwarding postage be sure to send a change of address to our office. Changes received by the 20th of the month can be made effective for following month's issue.

Stripping Unit, Model 401, manufactured by Oakite Products, Inc., New York, N. Y., is intended to simplify and speed up this maintenance work.

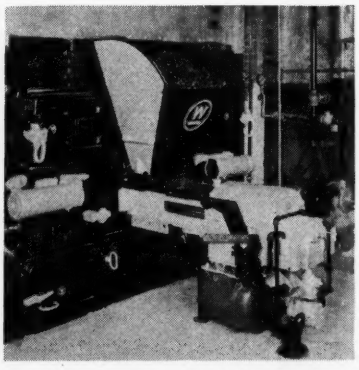
The method enables built-up coatings of paint to be removed quickly and satisfactorily by spraying a section of the transformer for a few minutes which reduces the coating of paint to the consistency of soft mud, after which it may be easily removed by a thorough rinsing.



The unit consists of a tank mounted on skids for easy portability, and contains the stripping solution. A pressure blue flame, supplied by kerosene blast torches, passes through submerged steel tubes of large diameter, thereby keeping the stripping solution at the required temperature. An electrically operated pump delivers the solution through a discharge hose and hand nozzle to the surfaces to be stripped. Flowing evenly down over the painted area, the solution falls into catch pans or troughs located at the bottom of the transformer. A second pump returns the solution to the tank, where it is heated to the proper temperature and again allowed to flow onto the painted surfaces. Where steam is available, a closed steam coil may be used to heat the solution instead of kerosene blast torches.

Hydraulic Drive Stoker

FOR DRIVING single retort underfeed stokers, Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa., has developed a hydraulic cylinder drive using a constant speed motor driven pump. It is said that



this development involves a unique valve mechanism which: provides the speed characteristics necessary for economical stoker operation; is mechanically simple; and provides for separate control of air supply and fuel feed when using one constant speed motor for driving both the hydraulic pressure pump and the forced draft blower.

Bronze is more precious than gold. It has become important to you, then, as a user of Bronze Valves, that Pratt & Cady patented the Bronze Globe Valve with renewable seat and disc—and that Reading-Pratt & Cady have continually developed the principles of that patent.

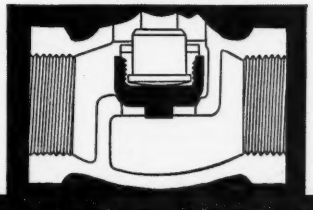
★ For example, when, through long use, a Bronze Globe Valve finally becomes worn, you don't need to replace the stout body of special hard bronze or the high strength rolled bronze stem. They are still in excellent condition. . . . Your maintenance job is limited to first regrinding to a fresh seat and then, finally, replacing no more than the seat and disc—using a minimum of metal that is scarce and of time that is vital. . . . So don't even think of *replacing* your Bronze Valves—MAINTAIN THEM CAREFULLY—REPAIR THEM—RENEW WORN PARTS.

If we can be of practical service, we'd like to help—in spite of the pressure of manufacturing schedules filled to capacity with the business of America at war. If we can, we will. Let us have the details of what you believe should be done for your valves.

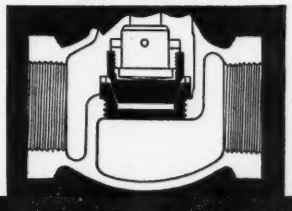
As a matter of service to America, may we suggest that you sort all metal scrap carefully, protect it from the elements and pass it back to industry through a responsible dealer. Make this part of your program. There is a tragic shortage of scrap.

READING-PRATT & CADY
READING, PENNSYLVANIA

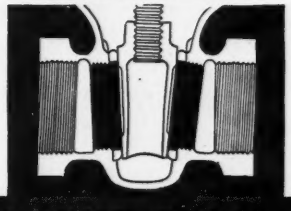
REGRINDING GLOBE VALVE
REGRIND AND RENEW



SEMI-PLUG TYPE GLOBE VALVE
REGRIND AND RENEW

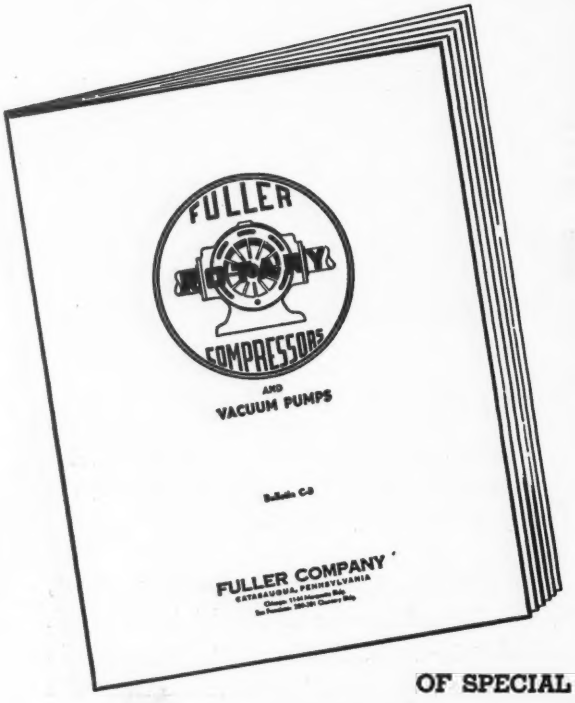


BRONZE GATE VALVE
REVERSE WEDGE—RENEW



A Division of AMERICAN CHAIN & CABLE COMPANY, INC. Bridgeport, Conn.

FULLER ROTARY COMPRESSORS
AND
VACUUM PUMPS
ARE DESCRIBED
IN THIS NEW BULLETIN



OF SPECIAL INTE T TO
SUPERINTENDENTS AND MAIN ANCE
MEN LOOKING FOR LOW-COST OP TION

If you are interested in compressed air or gases, capacities to 1800 C.F.M. actual free-air delivery, pressures to 125-lb.—vacuums to 29.90-in., (referred to 30-in. barometer), you should investigate these highly efficient machines. This new bulletin illustrates and describes these units . . . send for your copy today . . . just fill in the coupon.

FULLER COMPANY
CATASAUQUA, PENNSYLVANIA

Chicago: 1144 Marquette Bldg.
San Francisco: 320-321 Chancery Bldg.

C-66

FULLER COMPANY
Catasauqua, Pa.
Please send me a copy of Bulletin C-5.
Name..... Title.....
Company .....
Address .....
City..... State.....

Elipso Standlite

ANNOUNCEMENT is made by the Goodrich Electric Co., Chicago, Ill., of the new Elipso Standlite for protective illumination around industrial plants, conforming with FBI specifications. Due to elliptical shape, the fixture provides wide lateral distribution of light, which, with proper spacing of fixtures, creates a brilliant barrier of light around property lines without

illuminating buildings and grounds, watchmen remaining in the darkness.

Available in the two styles shown. While the direct style delivers light laterally, the angle style provides a slight forward throw.

MANUFACTURERS' NEWS

International Filter Co., Chicago, Ill., has changed its corporate name to "Infilco Incorporated." Organized 48 yr. ago during the pioneering era of water purification, Infilco's early activities were in the design and development of filters and filter plant equipment. Thirty years ago the company started manufacture of water softeners and other water conditioning equipment. Today, with equipment of every type and size needed to meet modern requirements of boiler feedwater conditioning, cooling water treatment and all other water purification problems. the officials felt the company should have a name of broader scope.

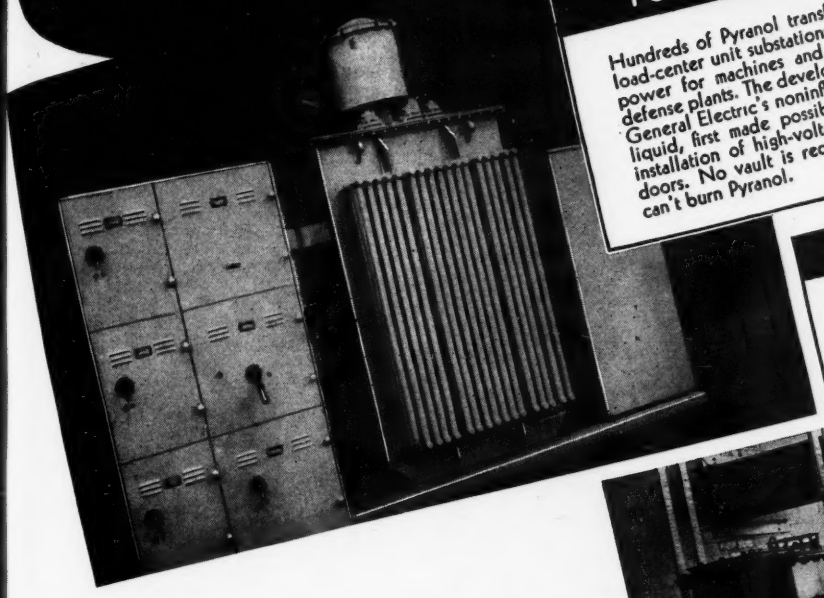
Pomona Pump Co. announces the purchase of the Westco Pump Division of Micro-Westco, Inc., Bettendorf, Ia. The newly acquired business will be operated as Pomona Pump Co., Westco Division, at 2621 Locust St., St. Louis, Mo., and manufacture continued from the St. Louis plant of the Pomona Pump Co. Management and key personnel of Westco will be transferred to St. Louis to continue the manufacture and distribution of the complete line of Westco pumps through the same national organization which has been carefully built up by Westco over the past 16 yr.

An arc welding news house organ, the Hobart Arc Welding News is now being published by Hobart Brothers Co., Troy, O., and will be sent free of charge to anyone writing the company's Direct Mail department and asking to be placed on the regular magazine mailing list.

The 200-ft. extension to the Clark Bros. Co. plant at Olean, N. Y., has recently been completed to house the manufacture of large triple-expansion marine steam engines, in connection with the government's defense program. The new marine engine is the largest Clark has ever built, the 2500 hp. unit being 22 ft. high, 23 ft. long, and 16 ft. wide with a stroke of 48 in. and a speed of 76 r.p.m.

Why the Rapid Growth in the Use of

PYRANOL TRANSFORMERS?

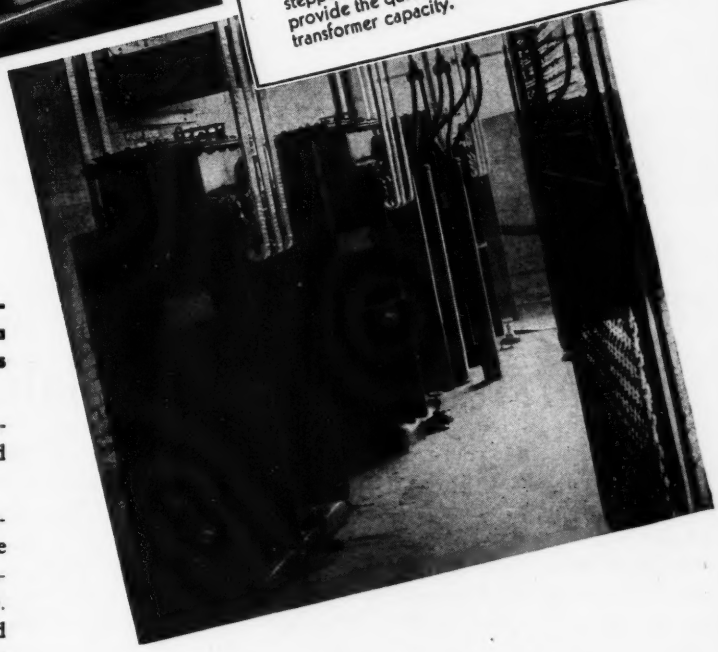


FOR NEW PLANTS

Hundreds of Pyranol transformers—in G-E load-center unit substations—are supplying power for machines and lighting in new defense plants. The development of Pyranol, General Electric's noninflammable insulating liquid, first made possible the economical installation of high-voltage transformers indoors. No vault is required, because you can't burn Pyranol.

FOR PLANT EXPANSION

When this plant needed more power, it installed these Pyranol transformers indoors. They bring primary power close to the load. Long runs of heavy secondaries are eliminated, effecting major savings in copper. For plants that must have more power for stepped-up production, Pyranol transformers provide the quick, safe method of increasing transformer capacity.



HERE'S WHY

PYRANOL* transformers can be installed indoors—right at load centers—without a fireproof vault. This speeds installation and saves materials, particularly copper.

Pyranol is noninflammable, and no Pyranol transformer in the 10 years since Pyranol was introduced has burned, or contributed to a fire.

Pyranol transformers require little, if any, maintenance. Pyranol is nonoxidizing and nonsludging. The pressure-tight tank protects vital parts of the transformers against moisture, dirt, dust, and sabotage. Immersion of the transformer interior in the liquid Pyranol prevents drying and cracking of the winding insulation.

Pyranol transformers have high dielectric strength, both at normal frequency and impulse, which means greater ability to withstand voltage surges that originate from switching operations or lightning.

The heat-storage capacity inherent in liquid-filled transformers makes Pyranol units ideal for sustained emergency overloads.

The reliability of Pyranol transformers has been proved by 10 years of service. Total installed capacity of Pyranol transformers is more than 2,000,000 kva.

For complete information on Pyranol transformers for your requirements, consult your G-E representative. Or, write for Bulletin GEA-2048C. *General Electric, Schenectady, N. Y.*

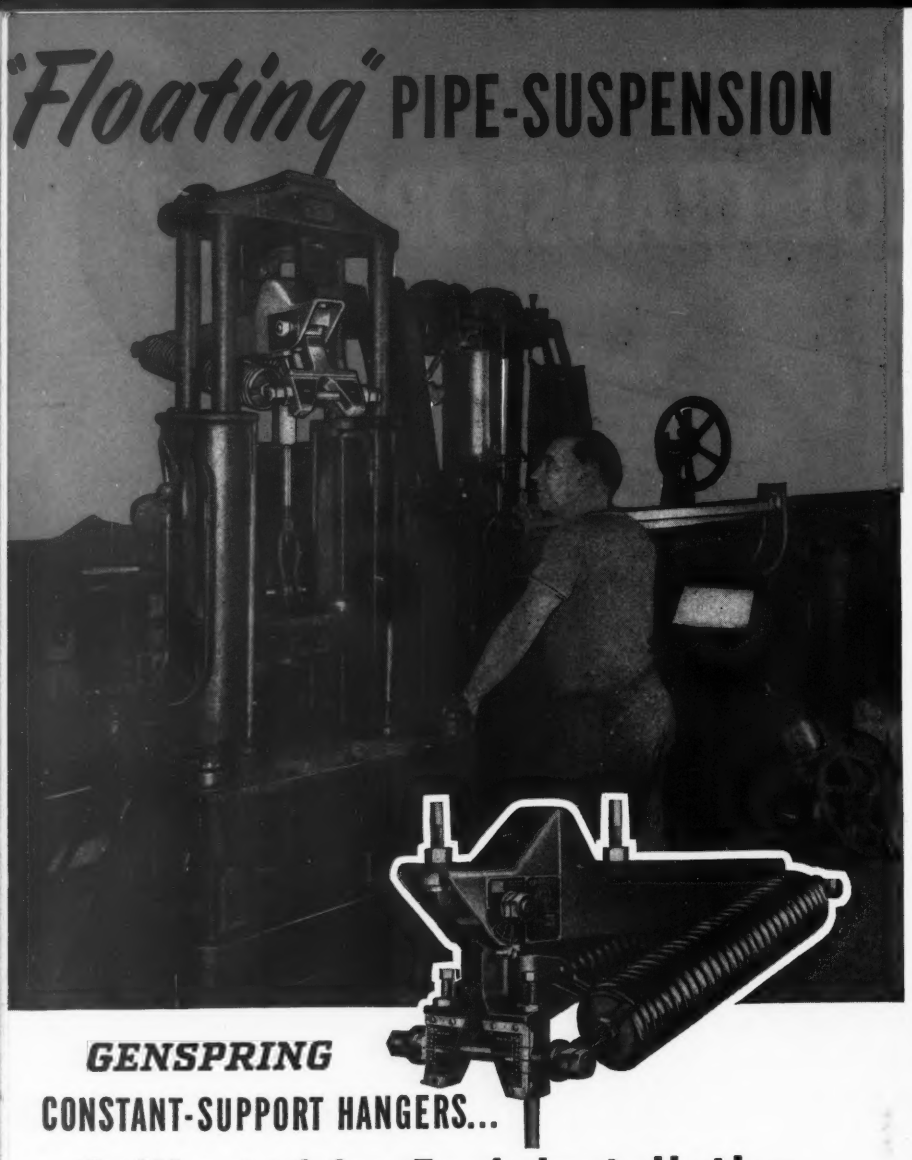
*Reg. U.S. Pat. Off.

General Electric and its employees are proud of the Navy award of Excellence made to its Erie Works for the manufacture of naval ordnance.

GENERAL ELECTRIC

403-40-5100

"Floating" PIPE-SUSPENSION



GENSPRING CONSTANT-SUPPORT HANGERS...

Calibrated for Each Installation

Before shipment to you, every GENSPRING Constant-Support Hanger for power piping is *individually* tested at the factory under load-and-travel conditions that duplicate the actual service specifications. However, should you find it necessary, field adjustments up to ± 16% of the hanger's rated load are easily made.

These are only two of the manufacturing and design features that make GENSPRING the outstanding hanger for today's high-temperature power service. Through unique engineering design GENSPRING Hangers provide constant support for piping in every "hot" and "cold" position. The weight of pipe is always in perfect balance . . . transfer of vertical vibration to the pipe structure is eliminated . . . the safety factor of the complete piping system is effectively maintained. Yet they require a minimum of headroom.

Investigate the exclusive advantages of GENSPRING Constant-Support Hangers available to support loads from 250 to 8500 pounds. Their cost is kept to a minimum through interchangeable parts and mass production. Grinnell Company, Inc., Executive Offices, Providence, R. I. Branch offices in principal cities of U. S. and Canada.

WRITE FOR complete Data Book on GENSPRING Hangers containing piping-travel calculations.

GENSPRING CONSTANT-SUPPORT HANGERS BY

GRINNELL

WHENEVER **PIPING** IS INVOLVED

The Union of South Africa has recognized the tremendous part arc welding is playing in the war effort by the issuance of a special postage stamp. This indicates that the Union is utilizing this new industrial art in the construction of her ships, tanks, aircraft and similar equipment. Stamps of 6d value are printed both in English, and Afrikaan, as is the case with all stamps issued in South Africa. The stamp depicts a welder using modern shielded electric arc equipment and dressed in protective head shield, gloves and other special clothing. Lincoln Electric Co. officials who are thoroughly familiar with the progress of electric welding say that, as far as they know, this is the first time that such a stamp has been issued.

The Chapman Valve Co., Indian Orchard, Mass., has concluded arrangements with the Defense Plant Corp., Washington, D. C., for the construction and operation of new local plant for the production of ordnance equipment. It will consist of two main one-story units, about 480 by 600 ft., and 75 by 300 ft. to be used for a foundry and machine shop respectively, and also several smaller buildings for miscellaneous service. The entire project is estimated to cost about $3,000,000. Plans are being completed by Stone & Webster Eng. Corp., 49 Federal St., Boston, Mass.

Westinghouse recently announced a license agreement, authorizing the Joshua Hendy Iron Works, Sunnydale, Cal., to use its plans and processes to produce marine turbines, gears and auxiliary apparatus as a means of speeding up production, for the Navy and the U. S. Maritime Commission, of vital propulsion equipment.

Joshua Hendy Iron Works was established in 1856 as a metal fabricating concern. The Hendy plant is now at work on reciprocating steam engines for Liberty type cargo ships being built at Portland, Oregon; Los Angeles and Richmond, Cal., and they will be the first west coast firm to manufacture turbine geared propulsion equipment.

Brown, Boveri 50 Yr. Old

On October 2, 1941, Brown, Boveri & Co., Ltd. of Baden, Switzerland completed the first half century of its existence. Charles E. L. Brown, elder son of an English mechanical engineer, settled in Switzerland in 1851 and acquired prominence throughout Europe as designer of the 3-ph. generator and transformer used in the world's first long-distance power transmission. This line from Lauffen on the Neckar River in Wurttemberg to Frankfort-on-Main, a distance of about 110 mi., transmitted 230 kv-a. at 25,000 v. to the exposition of the International Electrotechnical Congress in 1890.

Contacts made during this international gathering brought to maturity plans of Charles Brown and Walter Boveri, a young mechanical engineer, to found their own firm devoted to the production of electrical machinery and apparatus. Brown, Boveri & Co., was thus incorporated on October 2, 1891, and started actual production in February, 1892, with a staff of 120 employes. At the present time the total number of employes at the home-plant is 7200 while the entire concern including foreign affiliates provides employment for over 40,000 persons.

Don't let this war catch you with your

BOILERS DOWN

WE'RE in the army now! Our job is production—and more production. And maximum production requires a continuous supply of power without the delay and inconvenience of frequent time out for boiler cleaning or repair.

In hundreds of industrial plants throughout the country, Graver Water Conditioning Equipment is eliminating these unnecessary delays and helping to "keep 'em rolling, flying, and sailing."

Graver has designed, built, and erected water conditioning equipment for more than thirty years. This experience is available to you whenever needed and Graver engineers are ready to discuss any specific water treating problems and to submit unbiased recommendations. And you assume no obligation when requesting this help.

If you haven't received your copies of the following bulletins, write for them today. We will see that they are sent immediately.

Bulletin 301. Pictures and describes Graver Pressure Filters. Explains general construction and contains specification tables for both horizontal and vertical types.

Bulletin 303. Fully describes the Graver Hot Process Water Softener. Also contains detail drawings of two types of equipment plus other interesting information.

Bulletin 307. Covers Graver Zeolite Water Softeners as well as the six types of Graver Zeolites. Contains a series of six interesting flow diagrams covering waters of various characteristics.

WATER SOFTENERS
FILTRATION SYSTEMS
CLARIFIERS
SEWAGE DISPOSAL EQUIPMENT
STEEL STORAGE TANKS
VAPOR CONSERVATION SYSTEMS
WELDED CONSTRUCTION
STRESS RELIEVING
X-RAYING
FABRICATED STEEL AND NON-CORROSIVE PLATE

Built by GRAVER

GRAVER TANK & MFG. CO., INC.

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4809-S Ted Ave.
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CABLE ADDRESS — GRATANK

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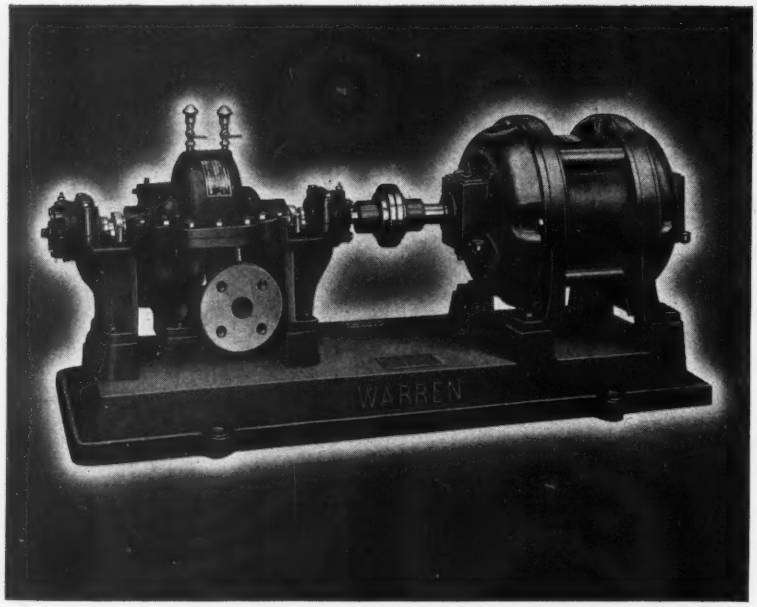
42-22-W



WARREN PUMPS
have liberal clearances

Close clearances between impeller and case rings in a centrifugal pump often make possible high shop test efficiency. But careful pump buyers know that excessive wear will quickly destroy that efficiency and result in increased power consumption, with possible overloaded driver.

In Warren Pumps, the guaranteed efficiencies are based on liberal clearances to make certain that they will be maintained for long periods.

Oversize bearings, extra-heavy shafts, large case rings and correctly designed impellers, are some of the many other reasons why Warren Pumps deliver the lowest pumping costs per year . . . year after year.

For further details ask for Bulletins 228 and 229

WARREN PUMPS
Warren Steam Pump Company, Inc., Warren, Massachusetts

Motors Power Pipe Line

EXTENDING SOME 1250 mi. from Baton Rouge, La., to Greensboro, N. C., the new Plantation Pipe Line will be powered by 900-hp. Westinghouse explosion-resisting motors, the largest ever built. The pipe line, starting at 12 in. diam. and changing to 10 in. at Bremen, Ga., will eventually deliver 90,000 bbl. a day. The initial capacity will be 60,000 bbl. and the provision to eventually increase this capacity by 50 per cent involved some interesting engineering problems. High pump efficiency was desired both now and when the power is increased by half, but without the expense of changing motors.

The answer was found in an improved version of a 3575 r.p.m. explosion-proof, squirrel-cage motor introduced about 4 yr. ago for pipeline service. By anticipating the future need for power, at the time the motors were built, it will be possible by minor modifications to slip up the power output of the 450-hp. motor to 600 and the 600-hp. one to 900, with no sacrifice in performance. Increased active iron and copper and the new high-temperature (class B) insulation have their part in increasing motor capacity without change in frame size.

MANUFACTURERS' PERSONALS

George H. Woodard has been appointed manager of the new products division of the Westinghouse Elec. & Mfg. Co., F. D. Newbury, vice president, announced. Mr. Woodard was born in Schenectady, N. Y., in 1906 and received his degree in mechanical engineering from Cornell University in 1928. He joined the Company when the new products division was created in 1936 for the development of products which have not reached the state of commercial apparatus.

Dr. C. F. Rassweiler, who joined Johns-Manville last June as director of research, was recently appointed a vice president of the company as announced by Lewis H. Brown, president. In his new capacity, Dr. Rassweiler will continue in charge of the company's research and development activities.

Walter Geist, vice president of the Allis-Chalmers Mfg. Co., is to head a new department, established to coordinate the company's sales policies as announced recently by W. C. Buchanan, president. The duties of this department will be not only to formulate and put into effect sales policies, but also to correlate and unify the selling activities for all the company's products, with the exception of those of the Tractor Department.

John J. Linker was recently placed in charge of production and engineering development of metallic and fabric packings and mechanical pump seals of the Crane Packing Co. of Chicago as announced by Frank E. Payne, president. Mr. Linker was formerly with the Flintkote Corp., prior to which he served as mechanical engineer with Stone and Webster Engineering Corp. and various marine companies.

Simple Way to STOP WASTE in the Boiler Room . . .

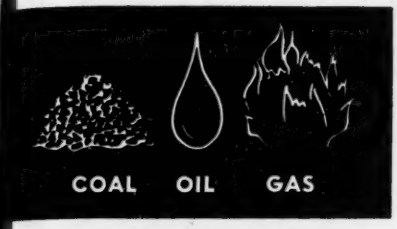
CASH STANDARD

AUTOMATIC COMBUSTION CONTROL SYSTEMS

Meet any condition • Work on any Boiler

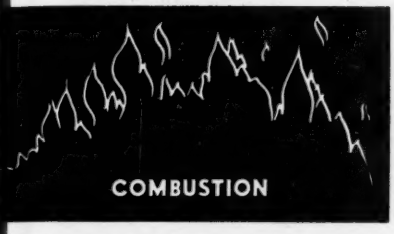
★ You get the exact amount of steam you need

—NO WASTE



★ The rate of fuel feed is adjusted exactly to load requirements

—NO WASTE



★ Flue Damper is changed in accordance with furnace conditions to prevent combustion losses due to excess air

—NO WASTE

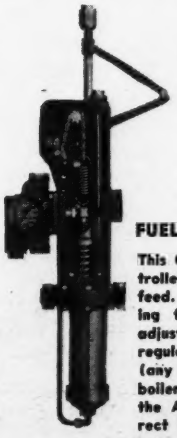
Each of the units shown is available in a number of variations to suit different requirements. Combinations can be arranged so that the full benefits of CASH STANDARD Automatic Combustion Control with its attendant savings can be realized by any plant even though it be a small one.

Try draft control—one part of the complete system—first, to experience for yourself how your fuel bill can be cut and yet how you get more steam. The Furnace Draft Controller installed separately gives you this opportunity. The rest of the CASH STANDARD Automatic Combustion System can be added later to give you the full cost savings that such systems make possible.

FURNACE DRAFT CONTROLLER

This CASH STANDARD Furnace Draft Controller (which comes complete with Operating Power Cylinder) works from overfire draft, regulating the boiler uptake damper to maintain a constant draft in the combustion chamber. Place it near the uptake damper. It works independently of either of the fuel feed and air flow Controllers. If it only eliminated wasteful air infiltration it would be a profitable investment.

Bulletin No. 300 gives full details on Automatic Combustion Control for steam plant economy and shows applications of these systems for those who burn coal, oil, or gas.

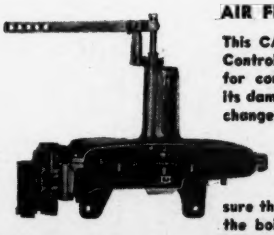


FUEL FEED CONTROLLER

This CASH STANDARD Master Controller automatically regulates fuel feed. Locate it conveniently. Working from boiler pressure, it will adjust the rate of combustion by regulating the rate at which fuel (any kind of fuel) is supplied to the boiler furnace. And it will adjust the Air Flow Controller so the correct amount of air is supplied for proper combustion — hence, money saving.

OIL CIRCULATOR

The purchase of this oil circulator is optional. All three Controllers shown above can be properly operated by clean water, but it is preferable and cheapest in the long run to operate with this CASH STANDARD Oil Circulator equipped with 110-220 v. 60 cy. motor.



AIR FLOW CONTROLLER

This CASH STANDARD Air Flow Controller meters the air needed for combustion. Install it near its damper. It is not affected by changes in fuel bed resistance or any other variables, because it meters air supply according to the differential pressure through the gas passages of the boiler, doing its part to insure perfect combustion.

A. W. CASH COMPANY
DECATUR, ILLINOIS

CASH STANDARD
CONTROLS . . VALVES

The Directors of Morris Machine Works, Baldwinsville, N. Y., announce the election of Stuart J. Saks as president of the company. Mr. Saks is a graduate of Syracuse University, and following an extensive sales and management experience, has been associated with the Company for the last 2½ yr. as assistant to the president.

In order to devote his entire time to his duties as Chief Engineer, J. D. Wood has resigned as President of the Roller-Smith Co. To fill the presidency relinquished by Mr. Wood the Board of Directors have elected Reg Halladay who has been a Director of the Roller-Smith Company since 1939. F. A. Judson, who joined the Company in September, 1941, as General Manager, was elected Treasurer.

Mumford Joins Combustion

ALBERT R. MUMFORD has been appointed to the Research Department of Combustion Engineering Co., Inc., under the direction of Henry Kreisinger, according to announcement by J. V. Santry, president of the company. Mr. Mumford's background in fuels combustion and steam generation covers four years as assistant fuels engineer of the U. S. Bureau of Mines, over fifteen years as research and design engineer with the New York Steam Corporation and from October 1938 to February 1942 as assistant director of research of the Consolidated Edison Company of New York. He is a graduate of M. A. T. in 1919 and has long been active in committee work of the A. S. M. E., N. D. H. A., A. S. H. & V. E. and the A. S. T. M.

Oakite Expands Facilities

OAKITE Products, Inc., announced recently the addition of two newly created divisions to its Nation-Wide Field Service Staff. The New England Division, with headquarters in Hartford, Conn. is headed by Mr. T. R. Smith, newly appointed Division Manager, who will supervise the activities of this division. The second division is the St. Louis and Southwestern Division, which will make its headquarters in St. Louis. Mr. S. C. Shank has been selected to fill the post of Division Manager. Mr. Smith has served for the past 16 yr. as an Oakite Service Representative in a major Eastern industrial area while Mr. Shank has covered a Mid-Western territory since 1930.

T. R. Smith

S. C. Shank

Caterpillar Personnel Changes

ORGANIZATION changes which followed the sudden death, January 23, of Thomas John Connor, vice president, have recently been announced by L. B. Neumiller, president of the Caterpillar Tractor Co. Harmon S. Eberhard has been elevated to a vice-presidency; a new Research Department has been created headed by C. G. A. Rosen; G. E. Burks is promoted to Chief Engineer; J. R. Munro to general factory manager and Charles A. Woodley to factory manager of the Tractor Division.

Mr. Eberhard, who was named Chief Engineer in charge of all engineering activities of caterpillar in 1933, now has administrative direction of Research, Engineering, Manufacturing, Industrial Relations and Training.

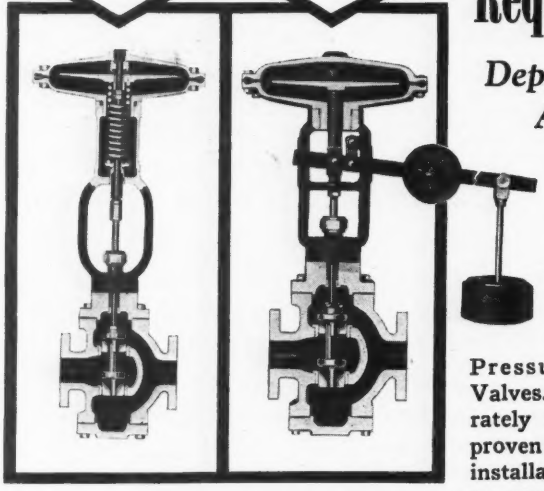
Mr. Burks is a native of Montana and attended University of Montana for 1 yr., then moved to California where he acquired his early engineering experience, continuing his studies through extension courses of the University of California. In 1928 he joined a caterpillar subsidiary, later transferred to the parent organization and in 1938 went to Peoria as Assistant Chief Engineer in charge of engine design.

Mr. Rosen is a native of San Francisco, Calif., was graduated from the Cogswell Polytechnic College and from the University of California. During World War I he served with the Naval Trial Board. He was connected with engineering staffs of several Diesel en-

FISHER

TYPE 57
Diaphragm Actuated. Spring Controlled Pressure Reducing Valve. Reduced pressure range ½ lb. to 100 lbs. For water, steam, gas and other fluids.

TYPE 10A
Diaphragm Actuated, Lever and Weight Controlled Pressure Reducing Valve. Reduced pressure range vacuum to 100 lbs. For steam, air or gas.



Pressure Reducing Valves

For All Power Plant Requirements!

Dependable and Accurate!

Types 57 and 10A, illustrated above, are direct operated, diaphragm actuated reducing valves available with angle or globe-type, screwed or flanged bodies. Globe bodies are easily inverted for conversion to relief valve service. Several types of inner valves available for various service conditions. Pressure setting easily adjusted. May be installed above or below pipe line.

● Complete satisfaction is assured with FISHER Pressure Reducing Valves. They are accurately engineered . . . proven on thousands of installations, and built to meet your specific operating conditions. No matter what your requirements, there is a FISHER Type and Size to meet your exact needs. Write for Fisher Bulletin C.

FISHER GOVERNOR COMPANY
1007 Fisher Building MARSHALLTOWN, IOWA

So THAT'S why WeldELLS line up so well—

IF you know WeldELLS, you know how easy it is to line them up. Of course there's a reason for this: Before machining, each WeldELL undergoes a "truing" operation to bring it to exact size and form. This operation assures the uniformly accurate bevel and land, and the true-circle ends that make WeldELLS just a little easier to line up and weld.

This extreme dimensional accuracy is just one reason why so many of the men who are responsible for the design, operation or maintenance of piping prefer WeldELLS—just one example of the limits to which we go to give *you* a welding fitting that "has everything."

A number of other features are listed opposite — extra-value features that are combined only in WeldELLS.

TAYLOR FORGE & PIPE WORKS

General Offices & Works: Chicago, P. O. Box 485
New York Office: 50 Church Street
Philadelphia Office: Broad Street Station Bldg.

WeldELLS have everything

In addition to the features described opposite, WeldELLS have the following advantages which are combined in no other welding fitting:

1. Seamless—greater strength and uniformity.
2. Tangents—keep weld away from zone of highest stress—simplify lining up.
3. Precision quarter-marked ends—simplify layout and help insure accuracy.
4. Selective reinforcement—Provides uniform strength.
5. Permanent and complete identification marking—saves time and errors in shop and field.
6. Wall thickness never less than specification minimum — assures full strength and long life.
7. Machine tool beveled ends—provides best welding surface and accurate bevel and land.
8. The most complete line of Welding Fittings and Forged Steel Flanges in the world—insures complete and undivided responsibility.

gine manufacturers and for 6 yr. maintained his own offices as consulting engineer. In 1929 he joined the Company as engineer in charge of Diesel development, later becoming Assistant Chief Engineer in charge of Diesel research.

Mr. Munro was born within a few blocks of the company's California plant, where he started work as an apprentice at the age of 15. Completing his apprenticeship in 1922, he advanced continuously becoming Assistant Superintendent of Engine and Tractor Assembly in 1933; Superintendent of Diesel Engine Assembly and Testing a year later and Factory Manager of the entire Tractor and Engine Divisions in 1936.

Mr. Woodley also got his start as an apprentice. Born in Pekin, Ill. he was accepted for apprentice training in 1926. He was graduated in 1930 and started work as a lathe operator in the machine shop, advancing through the inspection, tool room and planning departments to a foremanship in 1934, general foreman in 1937 and Supervisor of Industrial Engine Assembly in 1938. In 1941 he was made assistant factory manager.

Clemens on Erie City Board

JOHN D. CLEMENS was named to succeed his father, the late Hays H. Clemens as a member of the board of directors of the Erie City Iron Works.

Frank G. Brinig, who has served the company for several years as general manager, was named president, a position formerly held by the late Mr. Clemens.

Dudley Selden, sales manager, was elected vice-president and Edward P. Selden was named secretary.

Edward C. Moore, who has been with the company for 57 yr. and has served as vice-president and treasurer for many years, was elected chairman of the board and will continue in charge of the company's financial affairs.

R-S Butterfly Valve Line

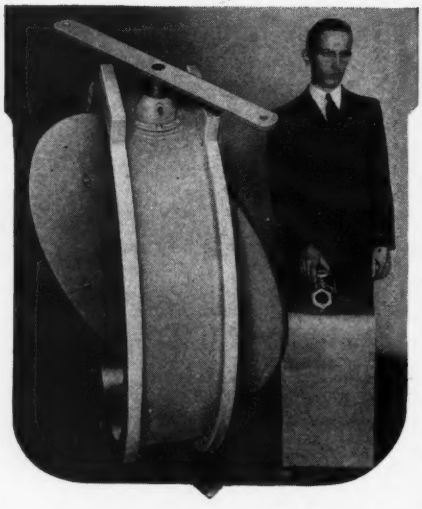
Stings the Maintenance Bill Every Time

Because of the non-complicated butterfly construction, accurate machining and careful inspection, R-S Butterfly Valves can be depended upon to provide flow control and wedge-tight shut-off for years. Maintenance is reduced to the minimum.

These valves, either manually or automatically controlled, are tight closing due to accurate machining and the angle of closing of the vane against the body of the valve. Manufactured in sizes from 2" to 84" and guaranteed for working pressures from 2 to 300 pounds as well as high and sub-zero temperatures.

Ersatz (Substitute) Metals

R-S has developed pressure iron castings for resistance against heat, abrasion and corrosion. They replace vital victory production metals and are considerably lower in price. For instance, R-S "A" Metal, a tough, dense metal of high endurance, is used in applications where hard wear and severe stresses are encountered. Has a tensile up to 50,000 p.s.i.—readily machinable. Details for the asking.



A 2" and a 48" Valve. Latter Is Lever Operated with Rotary Seal and Ball Bearings for Automatic Control.

Performance Data . . .
Flow Charts . . .
Specifications . . .

R-S Butterfly Valves — precision machined and wedge-tight for the regulation and shut-off of air, gas, steam, liquids and semi-solids —are either manually or automatically controlled. Write on your firm's letterhead for Catalog No. 10-B, which contains new facts and figures, much of which is published for the first time.

R-S PRODUCTS CORPORATION
4535 Germantown Avenue, Philadelphia, Pa.

NEWS FROM THE FIELD

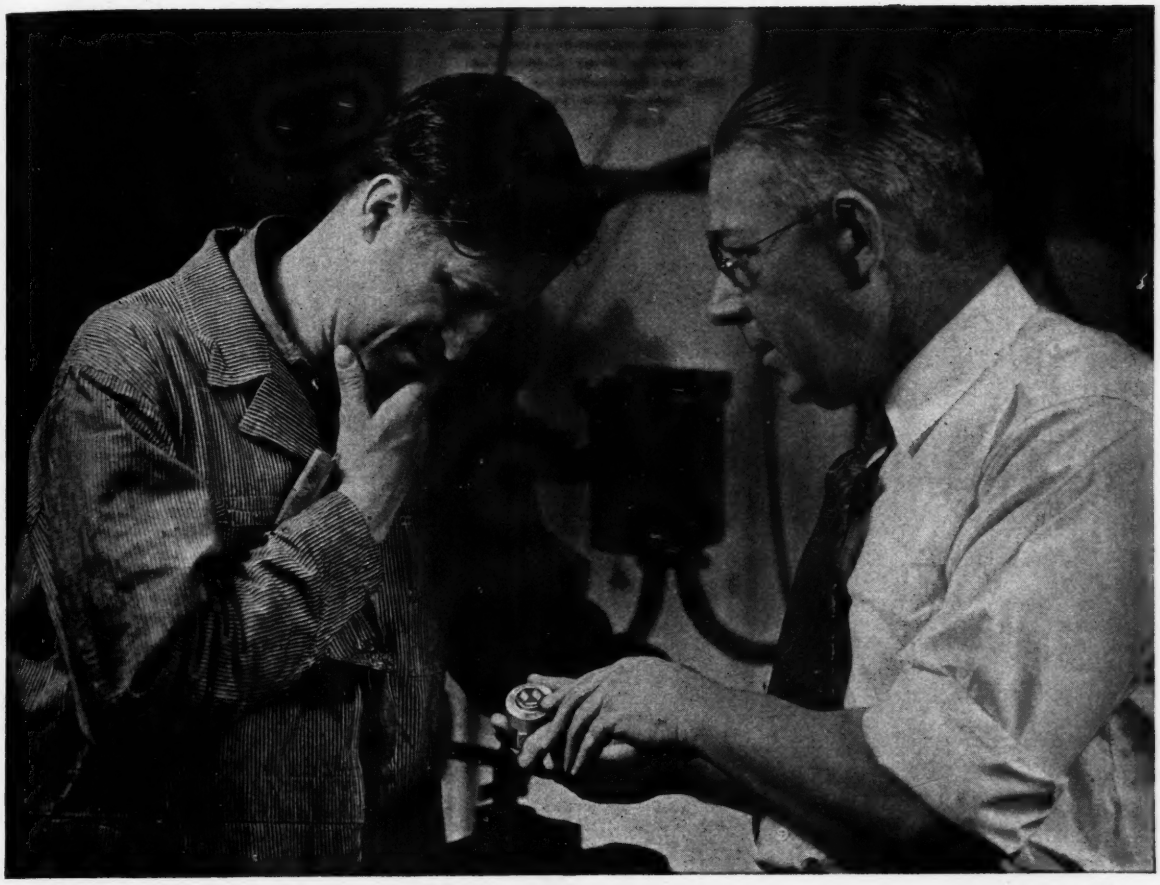
A. W. Thorson, of Detroit, assistant fuel service engineer for the Chesapeake & Ohio Railway Co. for the last 2 yr., has been recently appointed assistant to Robert E. Doherty, president of the Carnegie Institute of Technology. He will also aid Dr. H. H. Lowry, director of the Coal Research Laboratory, with its general business operations. He is a graduate of the University of Missouri and before his connection with the C. & O., was employed by The Detroit Edison Co.

Norman M. Albert, assistant engineer and superintendent of the Pacific Gas & Elec. Co.'s standardization laboratory at the company's Bureau of Tests and Inspection in Emeryville, Cal., has been appointed to the faculty of the University of California Defense Training School to conduct a course in electrical instruments and measurements.

A. M. Pitcher, formerly vice president of the Westvaco Chlorine Products Co., has joined The H. K. Ferguson Co., industrial engineers and builders of Cleveland and New York, as consulting chemical engineer. Mr. Pitcher was graduated from Swarthmore College in 1911, was with E. I. duPont de Nemours from 1911 to 1917, during 1918-19 he was with Chemical Warfare Service, assigned to Edgewood Arsenal, Baltimore, Md., and for the past 20 yr. as vice president in charge of production for the Westvaco Co. was responsible for production of plants at Charleston, W. Va., Cantenet, N. J., and Newark, Calif.

Fred Deppe, 78, retired the first of this year after 48 yr. service with the Nebraska Power Co. and its predecessors in Omaha, Neb. In expressing his appreciation of this service J. E. Davidson, president of the power company, said to Mr. Deppe: "We do not retire men because they have reached 65. An older man, with his experience, is often worth more to us than a young man learning the business. That has certainly been true in your case, Mr. Deppe." After working as machinist's helper, pump tender, oiler and engineer, Mr. Deppe became engineer at the electric building in 1926, which position he has held continuously since.

Frank L. Wadsworth, Engineer Associated, with Siegmund Firestone, Architect and Consulting Engineer of Rochester, N. Y., left a business connection of 20 yr. standing on Dec. 31st to work for the Navy Department in Washington, D. C. Mr. Wadsworth was a Naval Reserve Officer during the last World War and now has two sons in the United States Navy.



"See... here's why the chief insisted on Kennedys"

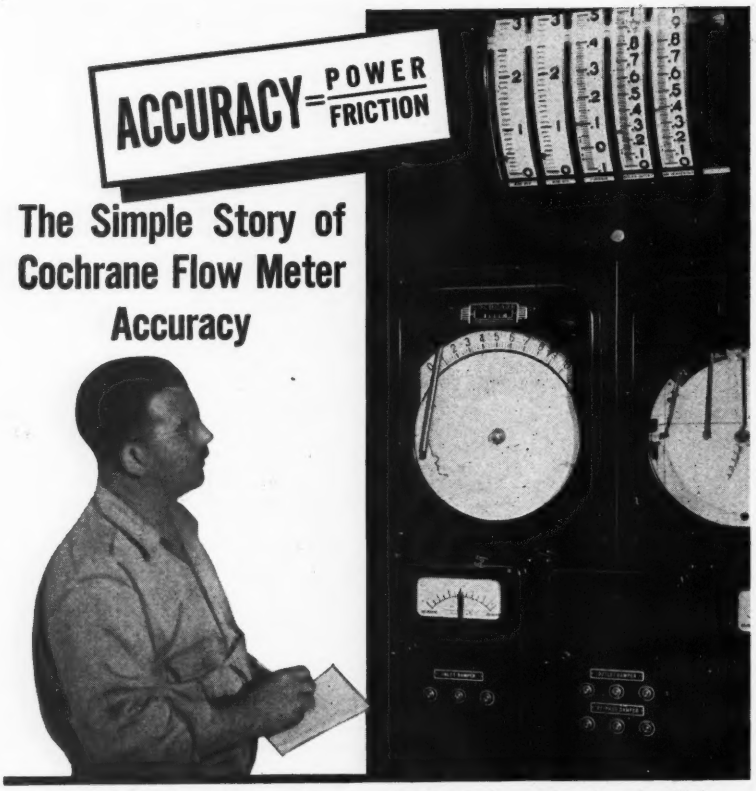
"I was curious to know why the old man was so insistent on having Kennedy Valves installed in our new defense plant . . . so I looked one over carefully. Why, Joe, they not only look good; they have quality in all the corners.

"For example, look how that practical disc holder locks itself on the stem . . . and yet, half a turn, and it drops off. It has four guide prongs, too. And all over the valve I found other little refinements, like the rounded bearing surface, the long threading on the stem, the extra-high raised seat, and the cadmium plated bonnet ring and packing nut. And get the heft of the whole valve. Did you ever see anything sturdier for 150 lbs.?"

Plant managers and engineers alike have learned that Kennedy Valves and Pipe Fittings on war projects help to assure dependable, uninterrupted, trouble-free production.

THE KENNEDY VALVE MFG. CO.
ELMIRA • NEW YORK

KENNEDY *valves... pipe fittings... fire hydrants*



HIGH ACCURACY in metering is achieved by (1) eliminating friction as far as possible (2) applying ample power to dwarf inherent friction.

Cochrane Flow Meters do both. Friction has been eliminated from the Cochrane Transmitter, while in the Cochrane Receiver the slight frictional load of pen, indicator and integrator is dwarfed by a powerful *external* source of power. The NULL Method, the basis of Cochrane design, makes this possible, the measuring circuit acting as a pilot for the application of power.

COCHRANE CORPORATION • 3123 N. 17th St. Philadelphia, Pa.

Cochrane
FLOW METERS

This 52 page booklet on flow meters, their design, construction and application, will be mailed on request. Ask for Cochrane Publication 3010.

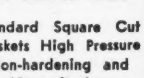
BETTER SERVICE — SAFETY — SATISFACTION
FOR REPLACEMENTS ORDER

PRECISION GAGE GLASSES and GAGE GLASS GASKETS THAT WILL NOT BLOW OUT

Standard Square Cut Gaskets High Pressure Non-hardening and Non-softening

GASKETS THAT WILL FIT EXACTLY

Red Lip-mold Pattern Expansion Type Gasket



Send for Glass and Gasket Chart

Shipment made by parcel post the same day as order is received

ERNST WATER COLUMN & GAGE CO.
RUBBER & GLASS DIVISION LIVINGSTON, NEW JERSEY

Approval of additions and extensions to the municipal power plant at Southport, N. C., was made recently by the Federal Works Agency as one of several Defense Public Works. The project involves an estimated cost of $91,142, of which $45,000 is a loan and the balance a grant. The Docket Number is N.C. 31-176.

The Narragansett Electric Co., Providence, R. I., will begin work soon on a new $2,500,000 generating station at Thompsons Corner on the Pawcatuck River at Westerly, R. I. Philip F. Creer, Providence, R. I., is the architect and United Engineers & Contractors, Inc., Philadelphia, Pa., is consulting engineer, and will supervise erection.

The United States Engineer Office, Tulsa, Okla., is completing surveys for proposed new power and flood control dam at Markham Ferry, about 2½ mi. from Locust Grove, La., on the Grand (Neosho) River. It will be about 90 ft. high, with crest length of approximately 3900 ft., creating a storage reservoir of about 187,000 acre-ft. An initial appropriation has been authorized, totaling $1,500,000, and additional funds will be provided as work progresses.

Under the chairmanship of P. L. G. Hasskarl of the Pennsylvania P. & L. Co., Allentown, Pa., the Executive Committee of the Public Utilities Section of the National Safety Council held its late fall meeting at the Pennsylvania Hotel, New York City, December 8 and 9. It was reported that many utilities are experiencing an increase in the number of accidents so that even though utilities were among the early pioneers in the organized Safety Movement, they have not escaped the present upward trend of accidents. Serious consideration was given to the building of an effective program for the next National Safety Congress to be held in Chicago during October, 1942.

Detroit Engineers Move to New Quarters

WHAT are probably the most complete and impressive engineering society quarters in the country were dedicated in Detroit late in January at an impressive ceremony participated in by: the governor of Michigan; the pesident of the University of Michigan; Harvey M. Merker, president of the Engineering Society of Detroit; and Alex Dow and James W. Parker of the Detroit Edison Co.

The new two story and basement structure of white Georgia Marble occupies a full block in Detroit's Art Center and is T shaped, 404 ft. long, extending back 150 ft. in the center and 65 ft. in the wings. The west wing is occupied by the University of Michigan, the east wing by the Engineering Society of Detroit. The central or auditorium section, with a banquet room in the basement, is shared jointly.

In addition, the engineers' wing has a smaller auditorium, dining room, lounge library, business offices, smaller meeting rooms, bowling alleys, billiard room and separate quarters for the Junior Section. The new building, known as the Horace H. Rackham Educational Memorial, was provided for from the will of Horace H. Rackham, a Detroit lawyer who laid the basis of his fortune by an early invest-

Control

American industry is geared up to the final test which will determine whether or not men, living under a government of their own making, can out-produce the slaves of the Dictator States. So gigantic an undertaking, to be successful, demands Control, sure—precise——unfailing. Control of the efforts of men, Control of the power that drives the machines and last, but not least, Control of the liquids and gases that play so important a part in the processes of modern production.

It is to this phase of Industrial Control that Powell engineers have long devoted their time, their exceptional skill and their years of experience. During this period they have created and put into use a vast array of valves, each one especially designed to perform some specific type of Control. These constitute the Powell Line as it exists today. Tomorrow there will be others, for every day there are new problems of Control which Powell Engineers are called upon to solve.

Thus it is that to the leaders of industry the name Powell represents a service rather than a product. Thus it is that the Powell organization recognizes and assumes the responsibility for the solution of such problems of Industrial Control as must inevitably appear in the great test of industrial strength and skill which war has demanded of our country.

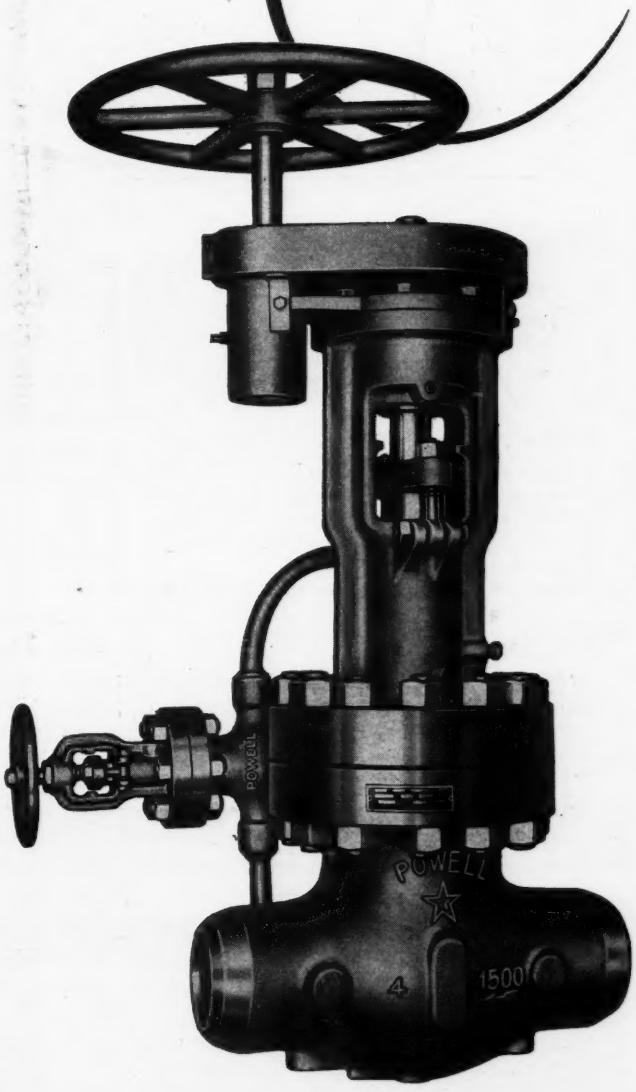


Illustration shows a 4" Class 1500 lb. cast alloy steel globe valve with welded by-pass. Spur gear operated. Welding ends. Body cast of welding grade steel.

The Wm. Powell Company
Cincinnati, Ohio

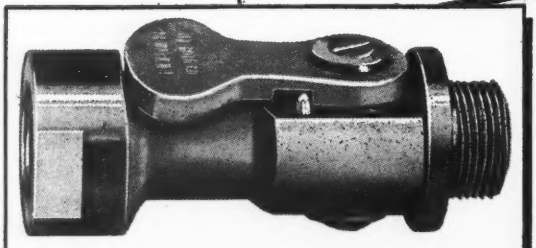
POWELL VALVES

These low-cost items save time, labor and money in tube cleaning

Anything that saves time, labor and materials is good news today. The accessories illustrated may be used with most makes of tube cleaners. Write for details.

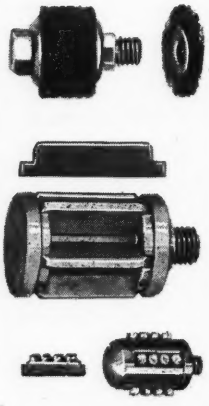
Combination drill heads offer savings

This head is an exclusive Roto economy feature. Consists of three separately replaceable parts, made of different materials to suit the type of wear to which each is subjected. Worn parts are renewed at great savings over the cost of ordinary one-piece drills.



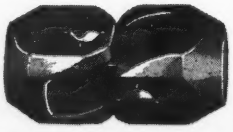
ROTO Air Valve saves the cost of a helper

Enables one man to operate the tube cleaner by himself. Saves time too, because it eliminates the necessity of signalling a helper to turn the air on and off between every tube cleaned. Attachable to most makes of cleaners for straight or curved tubes.



Made extra rugged for severe cleaner service

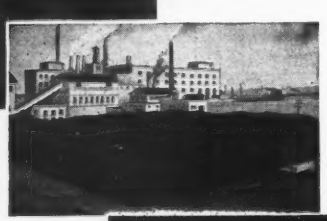
Ordinary universal joints soon loosen up under the severe abuse to which tube cleaners subject them. Roto joints are especially built to withstand such service. Note the peculiar way rivet heads are secured.



Replaceable parts save money cleaning small tubes

Roto brushes with replaceable sections (top), expanding scraper heads with renewable blades (center), and expanding brushes with replaceable sections (bottom) provide great economies in cleaning small tubular equipment. Roto heads give long, satisfactory service.

See Our Adv. in SWEET'S **The ROTO Company** 145 Sussex Ave., Newark, N. J.



SAUERMAN POWER SCRAPERS

10 to 600 tons per hour by one man

MAN-HOURS are vital these days. The Sauerman system of moving open storage coal is unique in simplicity of operation and it brings per-ton-moving costs way down. Our catalog describes this economical, trouble-free system. We would like to send you a copy.

SAUERMAN BROS., INC.
526 S. Clinton St.
CHICAGO, ILL.

ment in the Ford Motor Co. The original bequest was later increased by his widow, Mary A. Rackham.

In 1936, the old Detroit Engineering Society, an outgrowth of the Detroit Association of Graduate Engineers of the University of Michigan, founded in the 1890's, was reorganized and incorporated as The Engineering Society of Detroit. A trust fund of $500,000 from the Rackham Fund was later increased by an additional half million for building and furnishing a headquarters building. A later gift of $750,000 from Mrs. Rackham made possible the construction of the building as it now stands.

Information on Steel Tubing

INFORMATION on the availability of various grades and sizes of seamless steel tubing for new or special war-time requirements is now available from the Seamless Steel Tube Institute, Gulf Building, Pittsburgh, Pa. Two classes of tube purchasers may be benefited by this service. First, are those who have bought certain grades of tubing for use in peace-time products, but may be unfamiliar with sources of supply for other or special grades of tubing required for war equipment. Second, are those manufacturers who never before needed seamless steel tubing.

N.A.F.M. 25 yr. Old

THE NATIONAL Association of Fan Manufacturers celebrated its 25th Anniversary at the Annual Meeting in Detroit, Mich., February 12, 1942. The scope of the association activities has been gradually enlarged during the years between 1917 and 1942 from that of a credit association to include research, engineering standards, educational work in the proper uses of air moving machinery, improved working conditions and other allied subjects.

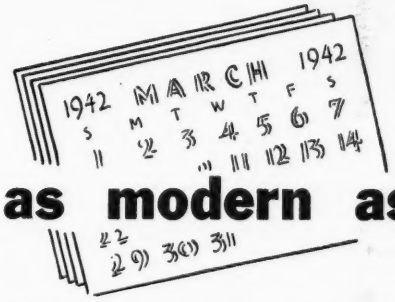
Research and study has been made of the effect of erosion, corrosion or the results of excessive heat as well as investigations covering the subjects of sound, air washers and field tests of fans. A program of standardization has been adopted to cover those types of centrifugal fans designed for application in, and furnished under specifications for the heating, ventilating and air conditioning fields.

Manly Becomes Vice-Chairman of F. P. C.

Commissioner Basil Manly has been elected vice-chairman of the Federal Power Commission for the coming year to succeed Commissioner Claude L. Draper, who has held the office of Vice-Chairman for the past 2 yr. Commissioner Manly has been a member of the Federal Power Commission since 1933, and was previously vice-chairman from 1933 to 1936.

In 1938 he was appointed by President Roosevelt as vice-chairman of the National Defense Power Committee, in which capacity he participated in devising plans for war-time mobilization of electric power supply. As Commissioner-in-Charge of the National Power Survey and Electric Rate Survey in 1933-1936, he supervised plans and reports for both of these pioneer undertakings. He also served as chairman of the Committee on Generation and Distribution, National Association of Railroad and Utilities Commissioners, in 1939.

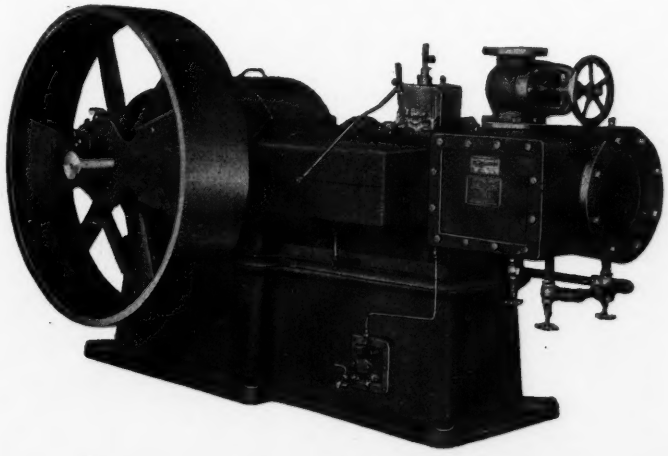
Today's
TROY-ENGBERG
Steam Engine

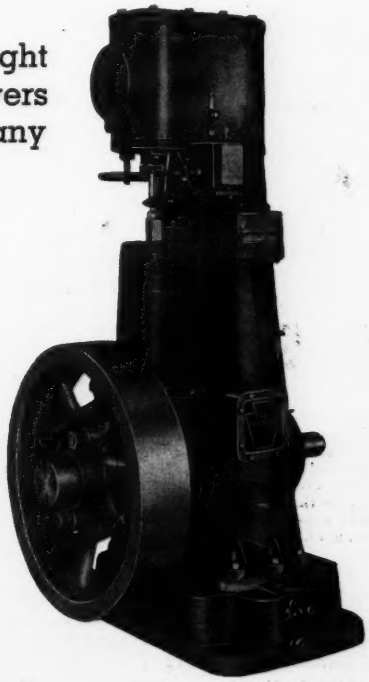


. . . as modern as today's calendar

During the past few years we have made some very careful detailed studies of over-all power costs—steam engine vs. other drives—right in plants using both and where competitive conditions prevailed. In many cases, the Troy-Engberg Steam Engines showed so much lower total power costs that there wasn't even a comparison.

Where conditions are right—and they are right in many plants—today's steam engine delivers dependable power at a lower cost than any other drive.

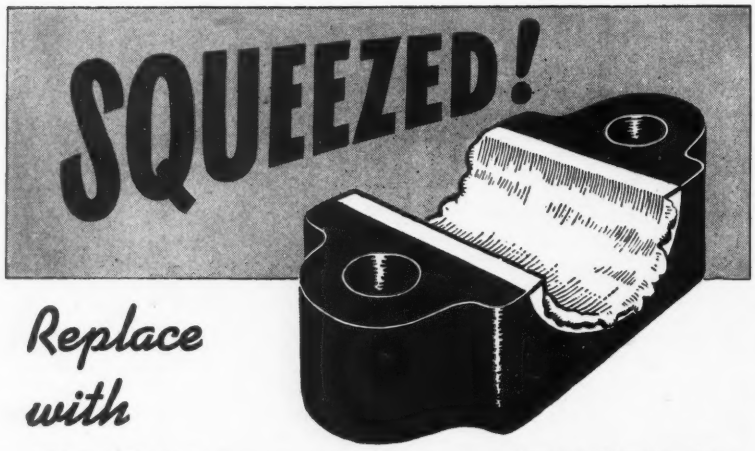




TROY ENGINE & MACHINE CO.

841 Railroad Ave., Troy, Pa.
Established 1870

3—TEM—1



Replace with

POWER Nickel-Genuine BABBITT

A uniform, nickel-treated, genuine babbitt alloyed particularly to withstand extremely heavy sustained pressures. A superior bearing metal in which hardness, strength and high melting and softening points are combined. For use in such machines as marine reciprocating engines, water turbines, paper mills and rolling mills.

MAGNOLIA METAL CO. • ELIZABETH, N. J.

MAGNOLIA BEARING METALS

DO YOUR PUMPS R-A-C-E TO MAINTAIN CAPACITY?

"Stop This Needless Steam Waste with COMBINATION Non-Slip Pump Valves," say Engineers

NOW, if ever, is the time to save the valuable steam lost through sluggish valve action of boiler feed, vacuum and service pumps.

COMBINATION Pump Valves help make steam-savers out of all reciprocating pumps. Their improved straight-lift, non-tilting valve construction enables the pumps to maintain theoretical capacity without racing. And their long-lasting bronze build means fewer pump shutdowns for overhauling, real savings in maintenance.

Watch Them Pay Their Way. After checking over many performance records where COMBINATION Pump Valves have returned their cost in from 3 to 9 months, we are prepared to make this liberal offer to engineers. These valves must pay their way on your particular pump job, or else they will not cost you a single penny. Either they make good, or we will. The coupon brings you full information about this opportunity to prevent steam wastage and too frequent pump repairs. Fill in and mail the coupon NOW.

This NON-TIL/TABLE Valve Closes Quickly, Reducing Wear. Prevents Slippage. Makes Steam Do More Work.

MAIL COUPON TODAY

COMBINATION PUMP VALVE CO.

846 Wiota Street **Philadelphia, Pa.**

I'm interested in getting more pump capacity with less steam. Without obligation, please send me full details about your Trial Offer on COMBINATION Pump Valves.

Name .....

Company .....

Address .....

Washington Award to W. L. Abbott

WILLIAM L. ABBOTT, veteran Chicago utility engineer, received the Washington Award for 1942. This award, founded in 1916 by John W. Alvord, is administered by the Western Society of Engineers in conjunction with the four founder societies for outstanding service in the engineering field. The award was conferred on Mr. Abbott for "advancing the standards of the engineering profession, for service to higher education and for aiding combustion research."

Mr. Abbott was born in Whiteside County, Ill., and graduated from the University of Illinois in 1884. Late in 1885 he was instrumental in forming the Wunder & Abbott Electric Co., operating a small electric plant in a downtown building. He sold his interest two years later and went to Ft. Wayne. He returned to Chicago and in 1889 assumed full control of the National Electric Construction Co. In 1894 he sold his interest in this company to the Chicago Edison Co.

In 1895 he was made chief engineer of the Edison Company's Harrison St. power house and in 1898 was appointed chief operating engineer of the company, a position he held until his retirement December 31, 1935. In 1904 he was elected trustee of the University of Illinois and later served as president of the Board for 14 yr., and the new power house at the University, built in 1941, was named after him. In addition to his many other activities, Mr. Abbott was president of the Western Society of Engineers in 1907 and president of the A.S.M.E. in 1926.

Chemical Exposition at Chicago

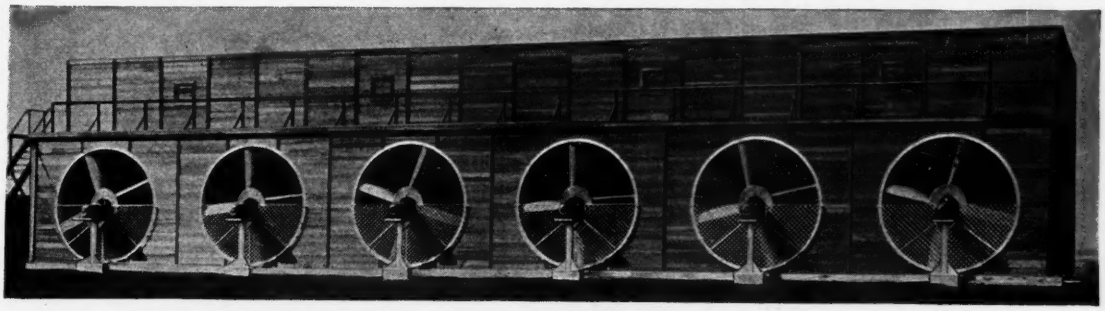
TERMED "the most important industrial exposition of the year on account of the war", plans are shaping for the second National Chemical Exposition sponsored by the Chicago Section of the American Chemical Society, to be held November 17 to 22 at the Stevens Hotel in Chicago.

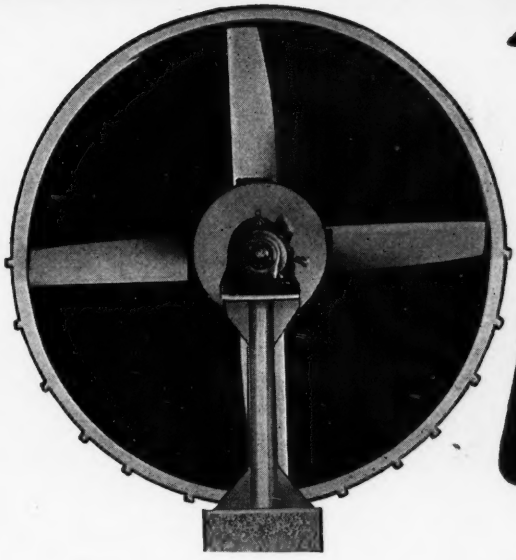
Victor Conquest, Director of Research for Armour & Co., chairman of the show committee, pointed out that added importance will be given the exposition this year because of the conference to be held in conjunction with a conference which will be addressed by leaders of the country. The program is now being arranged for this National Industrial Chemical Conference.

Serving with Mr. Conquest on the Exposition Committee are W. M. Hinman, Supt. of the Sensitizing Dept., Frederick Post Co.; L. E. May, Supt., Chemical Products, Sherwin-Williams Co.; R. C. Newton, Vice President, Swift & Co.; W. C. Johnson, Assoc. Prof. of Chemistry, University of Chicago; A. Guillaudeu, Research Chemist, Swift & Co.; and H. E. Robinson, Assistant Chief Chemist, Swift & Co. Marcus W. Hinson, who managed the first National Chemical Exposition, is acting in a similar capacity for this year's show. Headquarters are located at 110 N. Franklin St., Chicago.

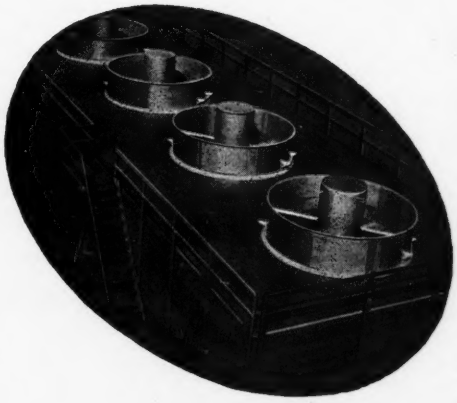
Public Service Budgets 15 Million

APPROXIMATELY $15,000,000 has been authorized by Public Service Corp. of N. J. on the 1942 construction budget for new equipment, extensions and replacements for its subsidiary operating companies. In addition $5,244,400 was





Here's ONE Big Reason For PRITCHARD Mechanical Draft EFFICIENCY AND ECONOMY



MORE than two years ago Pritchard designed the high efficiency "featherweight", axial flow, monel metal fans used since that time on all Pritchard mechanical draft installations. Today these fans are recognized as an outstanding contribution to mechanical draft efficiency and economy.

They are non-corrosive; don't pit. They are economical of power; reduce driving equipment wear. They provide uniform air flow across the entire fan opening.

Because of these fans, and other features, the operating cost of today's Pritchard towers has been reduced to new low levels.

Get the facts. Write for bulletins No. 42 and 42-A.

J. F. PRITCHARD and COMPANY

Dwight Building — Kansas City, Mo.

Branch offices in Tulsa, Okla.; Houston, Texas; Atlanta, Ga.; Chicago, Ill.; Pittsburgh, Pa.; New York City.

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Atmospheric and Mechanical Draft

WATER COOLING TOWERS

WE READ WATER

YOU TOO, CAN READ WATER

We have published a veritable water library—a fund of information on water treatment.

"Organic Methods of Scale & Corrosion Control," an authoritative 32-page treatise by David W. Haering, with 22 charts and photographs.

"Cooling Waters"—a 48-page booklet of articles on scale and corrosion in cooling systems.

"H-O-H Lighthouse Reprints"—48-page catalog containing a selected digest of articles on water treatment.

"The Solution of Your Proportioning Problem"—describes the popular Haering equipment for proportioning and sampling.

"Steam and Return System Control."

"Refrigerating Brines."

"Chrom Glucosates."

Write today for any of these and ten other booklets on water treatment for Power Plants, Refrigeration Plants, Petroleum Industry, Process Industries, Public Building and Transportation Industries.

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D. W. HAERING & CO., INC.
GENERAL OFFICES: 205 West Wacker Drive
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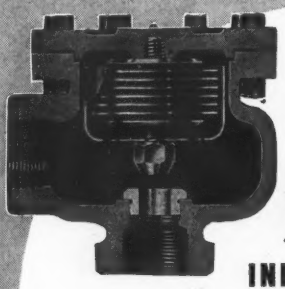


For All-Around Satisfaction, specify -

NICHOLSON
INDUSTRIAL STEAM TRAPS

★ Provide Valuable, Extra Large Discharge Capacity at No Extra Cost.

★ Cannot Freeze, Dribble, Water-Log or Air-Bind.

★ Quick, Positive Action Protects Heating Equipment and Shows Big Fuel Savings.

★ Need No Adjustment; Work on Pressures Up to 300 lb.

★ In Bronze, Cast Iron, Cast Steel, Sizes ¼ to 2 in.

★ Keep Unit Heaters, Pipe Coils and other steam using equipment at top efficiency.

Also: NICHOLSON Control Valves, Piston and Weight Operated Traps, Flexible Couplings, Welded Floats, Compression Shaft Couplings, Steam Eliminators and Separators, Compressed Air Traps, Expanding Mandrels, Arbor Presses

WRITE FOR BULLETINS—

W. H. NICHOLSON & CO.
160 OREGON ST. • WILKES-BARRE, PA.

appropriated to supplement the 1941 budget of $28,000,000. Under construction now are: a 125,000-kw. unit at Burlington Generating Station, to be ready early in 1943; and a 50,000-kw. unit at Marion Generating Station scheduled for completion by autumn of this year. When these units are placed in service, the total generating capacity of the Company's system will be 1,133,650-kw.

Aside from these generating projects, two important construction items included in this year's electric program are Bayway switching station, Elizabeth District, and reinforcement of facilities in the Camden area. In that area, an additional high voltage transmission line will be built on the company's right-of-way from Burlington Generating Station to Camden Switching Station. This project also provides for additional low voltage transmission lines and the rebuilding of Chester Substation.

World's Largest Forging Machines

WIDESPREAD attention is being attracted by current delivery of the world's largest forging machines, one in November and the other in February to Tube-Turns, Inc., at Louisville, Kentucky, where they will be put to work in the production of airplane motor cylinder forgings and other armament needs included in the defense orders held by this company.

These are rated at 9 in. capacity, a feat of designing and construction viewed as impossible a few years ago. Each machine weighs over 500,000 lb., and requires well over a year to build, yet this unit occupies floor space sufficient to accommodate only four automobiles.

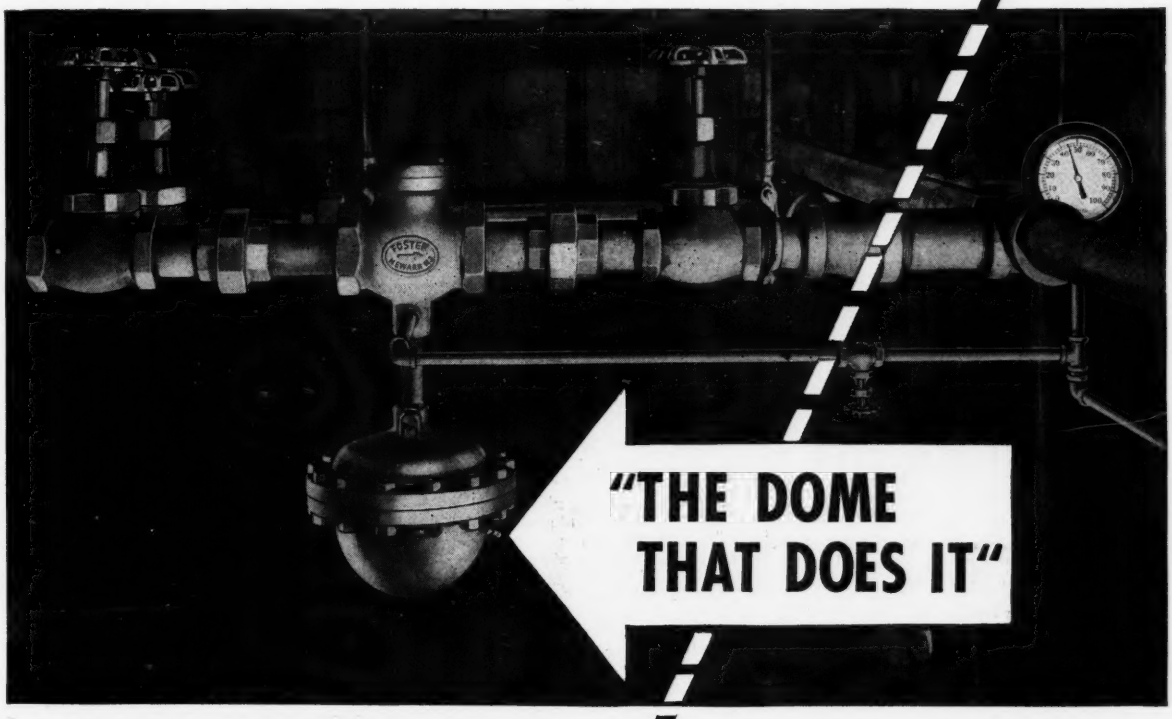
According to Tube-Turns, Inc., utmost in compactness in order to secure the greatest possible stiffness and rigidity is essential for the manufacture of accurate machine forgings, to insure freedom from spring, which in turn is reflected in greater accuracy in the work produced. Conditions to be met call for speed as well as accuracy and by-pass automatic grip relief plus a friction-slip flywheel, with new type of air cooled friction clutch starts the machine instantly, and at high speed. Positive control with complete safety enables the operator to obtain the highest output with the least manual effort. Ease and convenience of control, speed of operation and trouble-free performance are assured.

Indiana Utility Petitions F. P. C.

PUBLIC SERVICE CO. of Indiana, Inc., (formed September, 1941, by the consolidation of Public Service Co. of Ind., Dresser Power Corp., Central Indiana Power Co., Northern Indiana Power Co. and Terre Haute Electric Co., Inc.), has applied to the F.P.C. for permission to amortize the unamortized balance of $2,640,009.31 on bond issues of the former Public Service Company of Indiana refunded by that company in 1939 and 1941. Amortization of the balance is asked over the period beginning September 1, 1941, and ending December 31, 1946.

The applicant states that it believes that $2,640,009.31 should be amortized over a period of years following the dates of the long term debt refundings by its predecessor company, rather than

If pressure regulation is your problem, investigate



Typical installation of a Foster Type 39-Q1 Pressure Reducing Regulator. The gauge at the right shows the delivery pressure; the small line in the foreground is the pilot line; the valves on both sides of the regulator are stop valves, while the by-pass and its single stop valve can be seen directly behind the main line.

This type is built for initial pressures up to 2500 pounds per square inch; for delivery pressures up to 1200 pounds per square inch; and for temperatures up to 1000 degrees Fahrenheit. In addition to this single-seated type, double seating is available in the Foster Type 39-Q2.

Are you interested in accurate, sensitive pressure regulation in a valve that is as simple to set as letting a few pounds of air in—or out—of an automobile tire?

Then you should investigate the new Foster Type 39-Q1 Pressure Reducing Regulator and its revolutionary design feature . . . the "dome that does it."

There are no springs, no weights in this simple regulator. A constant load on the valve is imposed by the air pressure in the dome . . . accuracy of regulation is unaffected by spring deflection and hystersis.

Adjustment? Simply change the dome load and you change the delivery pressure. A few strokes of a hand pump or a "shot" from a compressed gas bottle increases the delivery pressure . . . while opening the check valve in the dome decreases the delivery pressure.

An eight page, fully illustrated bulletin containing complete information on this regulator is just off the press. A copy will be sent to you without cost or obligation . . . ask for Bulletin 10.

FOSTER ENGINEERING Company

PRESSURE REGULATORS • RELIEF AND BACK PRESSURE VALVES • AUTOMATIC STOP AND CHECK VALVES • ALTITUDE VALVES • DAMPER REGULATORS • FAN ENGINE REGULATORS PUMP GOVERNORS • TEMPERATURE REGULATORS • LIQUID LEVEL CONTROLLERS • FLOAT AND LEVER BALANCED VALVES • NON-RETURN AND TRIPLE DUTY VALVES • VACUUM REGULATORS OR BREAKERS • SIGHT FLOW BOXES • SIRENS • SAFETY VALVES

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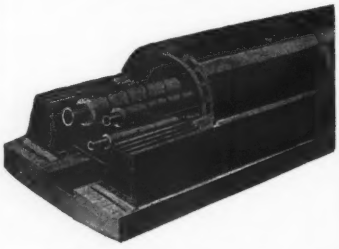
THERM-O-TILE

The only underground pipe conduit that is

TRULY COMPLETE

- **Simplest**
- **Strongest**
- **Most Efficient**



10 THERM-O-TILE ADVANTAGES

1. Less excavation is required for Multiple Pipe Systems than with other conduits.
2. Installation work can be started immediately since the tile is not required on the job until after the pipe has been installed and tested.
3. Pipe is supported on a solid concrete foundation which will hold permanently to a specific grade level. No condensate pockets.
4. Pipe is installed on concrete foundation with no interference of tile or other trades working in trench at the same time.
5. Conduit is installed with an internal drain in the concrete base which allows no accumulation of water in conduit due to steam leaks or water seepage through conduit.
6. Internal drains are connected through the manholes and not on the outside of manholes. This permits periodical inspection of drains for any possible leaks.
7. Due to the arch construction of the conduit, greater loads can be carried on top of the conduit than with round tile or other shapes.
8. Since no bell joints are used in the tile construction, Therm-O-Tile can be easily waterproofed with membrane waterproofing.
9. Repairs to steam line easily made by removal of top and side tiles at point of repair.
10. Greater thermal efficiency is secured since the installation is surrounded by air rather than by the heat-conducting damp earth.

In addition Therm-O-Tile is durable; permits movement of lines for expansion and contraction without harm to the pipe or insulation; cave-ins and inclement weather cause less damage and expense. And so on. Ask for Bulletin 381.

Sold and installed by Johns-Manville Construction Units in all Principal Cities.

See our page in Sweet's or The Heating Guide.

Complete Data and Estimates on Request.

H. W. PORTER & CO., Inc.

829-E Frelinghuysen Ave., Newark, N. J.

that the total amount should be charged immediately to income or earned surplus account in the respective years within which the refundings were consummated, because the immediate charging of the amounts to income or earned surplus accounts would produce a distortion of such accounts for the years in which such charges would be made.

Machinery Exports

UNITED STATES exports of industrial machinery in September showed an 18 per cent decline from the high figure of $41,976,614 reached in August, it was reported by the Department of Commerce. Practically all the export classes shared in the decline, with only textile, sewing, and shoe machinery showing any notable gain.

Total September exports of power-generating machinery amounted to $2,339,016 compared with $3,081,224 in August. Exports of marine Diesel engines dropped off sharply to $250,920 from $678,311, while shipments of other Diesel engines in September were up to $788,178 from $617,590 in August.

Arranges Budget for 1942

THE WISCONSIN Public Service Corp., Milwaukee, Wis., has authorized a fund of about $4,088,300 for extensions and improvements in power plants and system in 1942. Of this amount, approximately $2,300,000 will be used for expansion program now under way at the Bayside steam-electric generating plant at Green Bay, where a new 30,000-kw. turbine-generator unit and accessories, high-pressure boiler and auxiliary equipment will be installed. Work is scheduled for completion late next fall. Two new transmission lines will be built, as well as a number of extensions to present high-tension system. One new line will be built to Fond du Lac, Wis., where connection will be made for interchange of power with Wisconsin Power & Light Co.; another transmission line will be built from New Holstein to Elkhart Lake, Wis., where similar tie-in for interchange of power will be made with system of Wisconsin Electric Power Co. These extensions will cost over $360,000. Other work will include power substations, distributing lines and accessory field structures.

Obituaries

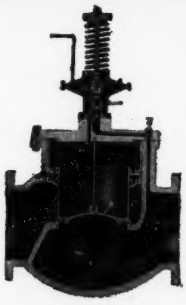
Hays H. Clemens

HAYS H. CLEMENS, president of the Erie City Iron Works and treasurer of the Hays Manufacturing Co., died suddenly of a heart attack on January 27 in Dallas, Texas. A member of a pioneer Erie family, Mr. Clemens was well known throughout the country as a leading industrialist. As head of the Erie City Iron Works he advanced the scope of that century-old concern and when the boiler and engine business slipped for a period during the influx of other methods of power generation it was he who revived the industry, working out plans for development in other fields.

He served as president of the American Engine and Boiler Manufacturers Association for many years, was a director of the Hays Manufacturing Co., a member of the board of directors of the American Cyanamid Co., which took over the old Erie Chemical Co.

See page 40 of our new 96-page catalog for information on this

SINGLE ACTING STANDARD ALTITUDE VALVE



Where a separate discharge line or bypass arrangement is used for removing storage water, this valve, placed in the upstream pressure line, will maintain a uniform water level in tank, standpipe or reservoir within a range of 3" to 12" variation.

GOLDEN-ANDERSON VALVE SPECIALTY CO.
Fulton Building Pittsburgh, Pa.

For **EFFICIENT OPERATION** you must **ACCURATELY** determine the phosphates in your boiler water!

AMONG the hazards of poorly conditioned boiler water are corrosion, pitting and inter-crystalline cracking. The famous Taylor Boiler Water Slide Comparator will save you dollars every day . . . help you cut down on boiler repairs and costly descaling shutdowns. Simplicity of determination, accuracy, speed and low cost are features that have made Taylor pH Slide Comparators standard equipment in prominent industrial plants. Write today for new 80-page booklet, "Modern pH and Chlorine Control," or see your dealer.

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STANDARD AND RENEWABLE VALVES FOR PRACTICALLY EVERY SERVICE

Fairbanks has been developing valves to meet new conditions as they arose for more than 50 years. As a result of these specialized efforts, Fairbanks Valves are available today in a large variety of sizes and types.

You can "Bank on Fairbanks" to supply pre-tested brass and iron, standard and extra heavy valves designed to meet practically any operating condition. Specify "Fairbanks" on your next order.

Your Fairbanks' distributor is prepared to handle your needs promptly. Write for his name and catalog No. 21.

1. **Prompt service through conveniently located distributors.**
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3. **Quality in design, materials and workmanship.**
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5. **Low in maintenance cost.**
6. **Maximum years of service assured.**
7. **Acclaimed for dependable performance.**
8. **Nationally accepted by users.**
9. **Backed by over 50 years' specialized experience.**
10. **Technical assistance in valve selection.**

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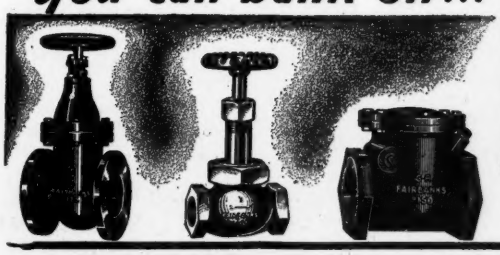

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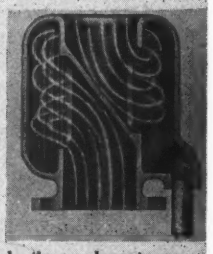
In more than
12,000 Plants
COCHRANE
MULTIPORT
RELIEF VALVE

Cochrane Multiport Back Pressure Relief Valve with front and back plates removed.

Successful operation of the Cochrane Multiport Valve in more than 12,000 plants is a sure guarantee of its continuously reliable operation. This continuous operation is insured by the multiport principle — a number of small discs instead of one large disc, eliminating the sticking, jamming and freezing common to single-disc valves in the control of atmospheric relief, back pressure, etc.

Call your Cochrane representative or write for further details.

COCHRANE Exhaust Head



Designed to separate condensate and oil from steam discharged to atmosphere and thereby prevent raining of water and oily condensate on the roof, Cochrane Exhaust Heads incorporate a highly efficient free-flowing baffle type construction and an exceptionally large port area which minimizes back pressure. Write for further details.

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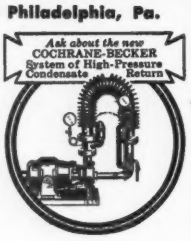
3123 N. 17th St., Philadelphia, Pa.

Rapidly removes hot condensate from steam process equipment and returns it to boiler at high pressure and close-to-process temperature. IMPROVES QUALITY, INCREASES PRODUCTION, CUTS COSTS.



Mr. Clemens was a graduate of Central High School in 1903 and in 1907 he was graduated from the Rensselaer Polytechnic College with a degree of mechanical engineering.

Walter D. La Mont

LIEUTENANT COMMANDER Walter Douglas La Mont, U.S.N., retired, died of a heart attack on January 19 at his home in New York in his fifty-third year. His burial took place with full military honors at Arlington Cemetery, Washington. He was born in Niagara Falls, N. Y., in 1889, graduated from Annapolis in 1910 and served in the Navy until he resigned in 1924.

Commander La Mont was best known to the power plant field as the inventor of the La Mont boiler which operates on the principle of forced boiler water circulation. As president of Steam Power Inc. and W. D. La Mont, Inc., many of his other inventions have been developed into commercial products and are now beginning to be placed in actual use in marine and other power plants in America, although they have been widely used in Europe for a number of years.

Reginald Pelham Bolton

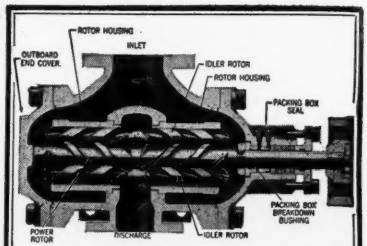
REGINALD PELHAM BOLTON, engineer and student of Colonial and Revolutionary history, died February 18 at his home in New York City after a short illness. Mr. Bolton was 86 yr. old and was president and chairman of the board of the Electric Meter Corp., New York, N. Y., and also president of R. P. Bolton Co.

As a consulting engineer, Mr. Bolton designed and erected machinery for mines, shipyards, marine engines, and power plants in all parts of the world. Since 1893 he has been actively engaged in consulting engineering in New York City. Mr. Bolton was born in London, England, on October 5, 1856, and was educated in private schools. He served his apprenticeship with Powis, James & Co., Lambeth, England. In 1879 he came to America and engaged in consulting practice and became associated with the A.S.H.V.E. in 1897 when he was elected a member. He served this society in many of its most important offices, including president, and in 1936 Honorary Membership was bestowed upon him.

Percy Nicholls

PERCY NICHOLLS, supervising engineer of the Fuels Section, U. S. Bureau of Mines, died on February 12 following an operation. Mr. Nicholls was born in London, June 4, 1870, graduated from Leeds University with a degree of B. S. in Engineering, and came to the United States in 1897. After his graduation he worked with Henry Berry & Co., Fairbairn, Naylor & McPherson, Charles Scriven & Co., and the General Electric Co. in England.

From 1898 to 1904 he was with Westinghouse Elec. & Mfg. Co., and during that time assisted in the establishment of the Westinghouse plant at Le Havre, France. In 1904 to 1909 he was with the Western Electric Co.; from 1909 to 1914 he was with the General Electric Co. In 1915 he became director of planning and research for Franklin Mfg. Co., Franklin, Pa., in which position he became interested in heat transmission and the use of solid fuels. From 1922 to 1925 he was on the staff of the A. S. H. V. E. Research Laboratory and then accepted appointment as supervising engineer of the Fuels Section, U. S. Bureau of Mines. Mr. Nicholls was the author of more than 50 papers



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The De Laval-IMO Oil Pump

1—*runs* at motor or turbine speeds,
2—*delivers* any oil in any volume against any pressure,
3—*occupies* small space, and
4—*uses* power efficiently.

But DOES NOT

a — have valves, gears, separate bearings or oscillating parts,
b — set up pulsation or vibration,
c — have high-pressure packing boxes, or
d — require disconnection of piping or disturbance of motor for internal inspection.

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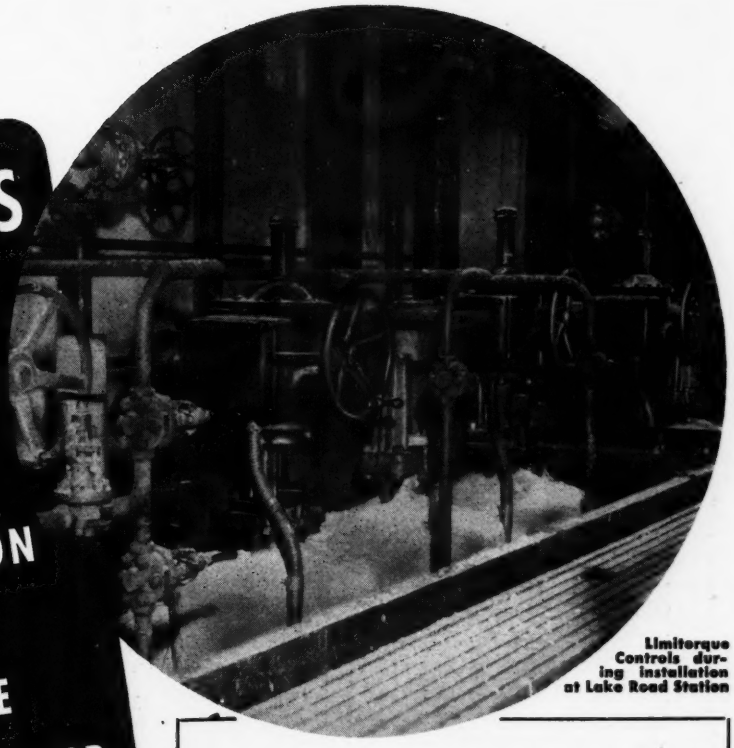
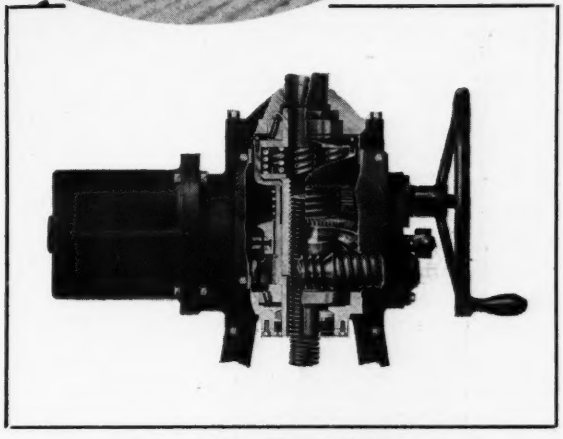
CLEVELAND'S NEW LAKE ROAD STATION GETS DEPENDABLE VALVE OPERATION WITH LIMITORQUE CONTROLS ON THE JOB



Limitorque Controls during installation at Lake Road Station



Cut-away view of Type S. Limitorque

INTO this new power plant went 23 Limitorque controls, 19 of which are in use on steam header valves, the other 4 on circulating water valves. These provide an unfailing means of opening or closing the valves from 2 central control panels. In time of emergency or in every day plant operation the valves are always under the control of responsible workmen.

Now is the time to plan to install Limitorque controls in new constructions or when modernizing the old. They are furnished for all types of valves from 3" to 96" diameter and are adaptable to existing equipment.

Write today for complete details.

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24 HOURS, 7 DAYS? Ranarex can take it!

The only mechanical

CO_2 INDICATOR and RECORDER

This sturdy watchdog of combustion efficiency can stand the heaviest strains. It contains no chemicals or fragile parts to break down . . . yet it gives instant readings within 3/10 of 1% CO_2. Cuts fuel waste as much as 20%.

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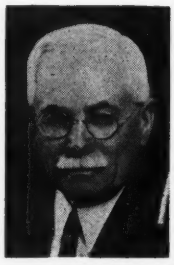
and pamphlets on technical subjects and, while at the Society's Laboratory, developed the Nicholls Heat Meter.

Mr. Nicholls joined the American Society of Heating and Ventilating Engineers in 1920 and became a Life Member in 1941. He served on many technical committees of the Society and assisted in developing the boiler testing and rating codes. At the time of his death he was chairman of the Society's Publication Committee.

In addition to his association with the A. S. H. V. E., Mr. Nicholls was a member of the A. S. M. E. and a charter member of the Physical Society of Pittsburgh.

Bion J. Arnold



COL. BION JOSEPH ARNOLD, for many years a consulting engineer with offices in Chicago, honored by universities with degrees of doctor of science and doctor of engineering, a pioneer in the development of airplanes, authority on electric railway construction and operation, Lieutenant Colonel in the U. S. Aviation Section, Signal Corps, during World War I, President of the A.I.E.E. in 1903-04, died in Chicago on January 29, 1942, while still Chairman of the Board of Supervising Engineers of the Chicago Surface Lines.

Mr. Arnold was born in Casnovia, Mich., August 14, 1861, spent his boyhood days in Ashland, Neb., and attended the Univ. of Nebr. one year but completed his undergraduate work at Hillside College, Michigan, in 1884. He was given the E.E. degree in '97 and Doc. Eng. degree in 1911 by the Univ. of Nebr.; the M.S. in 1887 and M.Ph. degrees in 1889 by Hillside College; took post graduate work at Cornell Uni. in 1888-89 and received the honorary Science Doctor's degree from Armour Institute in 1907.

His accomplishments in the engineering, army, navy and aviation fields are many and varied. The first commercial third rail system in this country was built by him for the World's Fair in 1893. His ardent work in professional engineering societies brought to him such honors and responsibilities as the presidency of the A.I.E.E. in 1903-04, and of the Western Soc. of Engrs. in 1906-07. The Washington Award was presented to him in 1929 in recognition of devoted, unselfish and preeminent service in advancing human progress and for pioneer work in engineering and economics of electrical transportation.

The passing of Mr. Arnold closes a career in engineering marked with successes few are privileged to attain. He was instrumental in developing and using electric power as we know it today almost from its infancy. He worked with the Wright Brothers in their early developments of airplanes. He contributed engineering literature for the benefit of others pioneering with him in the profession.

He planned engineering projects from their inception to their successful operation, many times inventing equipment and processes to carry his ideas into practical realities. The engineering profession is saddened by his death, but is proud to have claimed among its members a man so richly deserving of honors and who has done so much for the industry of the country and the welfare of its citizens.

YOU CAN BUY WITH CONFIDENCE

Unless a product or service is of real benefit to the user, it cannot long withstand the glaring light of advertising.

Manufacturers of boiler stokers, turbines, engines, pumps, piping, belting, motors and other equipment, who continue to advertise, must have products which have proved their worth by useful service. You can place full confidence in them and depend on them to deliver utmost value.

Take advantage, too, of the valuable installation and operation information given in the many new catalogs and special bulletins issued by manufacturers, and described regularly in Power Plant Engineering.

Let us know if we can help you solve any perplexing operation problems which come up in your daily work; or if you would like us to secure catalogs or data for you on any particular type of power equipment.

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Give him a chance to help you solve your boiler tube problem. He's anxious to serve you—*and can in many ways.* He may not be able to give you *all* the tubes you would like to have, but he won't stop trying.

When you put your problem up to your ELECTRUNITE Distributor, he tackles it as if it were his own. For today, *your* worries are *his* problems, and his business depends on his solving them. So, he has rolled up his sleeves and buckled down to the job of using all his facilities overtime to give you emergency service *now* when you need it most.

He may be able to supply promptly enough tubes from stock to make needed repairs—perhaps, the tubes for a new boiler, if it is to be used for *Production for Victory.* If he can't, he'll go the limit to get them for you. He may be able to suggest ways to lengthen the life of your tubes. He just never lets up in his effort to help you.

And you can help him, too—by *always* giving complete data on your preference rating extension with *every order.* In this way you enable your distributor to replace material furnished you from stock—you make it possible for the manufacturer to secure raw material to make the additional products you will need in *Production for Victory.*

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VALUABLE time saved—Installation costs reduced—Operating troubles eliminated . . . That's the story every time an Enco Fuel Oil Pumping and Heating System goes on the firing line.

Planned, built, and tested as a complete automatic unit—an Enco Pumping and Heating Unit needs only to be placed on its foundation and connected to the station piping. Within a few hours it is delivering fuel oil to the burners at the proper temperature and pressure required for efficient combustion—under full automatic control and with complete safety.

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Enco OIL BURNING EQUIPMENT

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Coupon for obtaining free literature listed here may be found on page 148, under the heading Helpful Bulletins.

PRIME MOVERS AND PUMPS

1 Turbine—Bulletin 1955, illustrates and describes the Type S Moore multi-stage steam turbines. Also included are special and standard features and application of various accessories. Moore Steam Turbine Div., Worthington Pump & Machinery Corp.

2 Diesel Engines—Nordberg Gas-Burning Diesels is the title of a new 8 pp., Bulletin 106, in colors, describing and bringing out the features of design and operation of a line of engines operating on the full Diesel principle and designed to be quickly converted to burn either natural gas or oil. Typical installation photographs and operating data are included. Nordberg Mfg. Co.

3 Water Pumps—Bulletin 400 illustrates and describes Rex Speed Prime Pumps made in capacities from 3000 to 125,000 g.p.h. Features include positive prime control, Rex Z-Metal impeller, patented air peeler and rotary seal and replaceable liners. Data on how to pick a pump for a specific job is also included. Chain Belt Co.

4 Pump Data—Bulletin 302 is a 6-p. folder devoted entirely to pump data including friction in pipes, resistance in valves and fittings, suction lifts, equivalent measures, viscosity conversion tables, specific gravities and the viscosities of some 100 different liquids for temperature ranges of from 17 to 190 deg. F. Blackmer Pump Co.

BOILER ROOM EQUIPMENT

5 Proportioning Machines—Automatic Treating, Feeding, Diluting, Blending, Proportioning and Sampling is the title of a completely descriptive 20-p. Bulletin TOU-6. Included are illustrations and applications of various types of proportioners, feeders, controls and units. Proportioneers, Inc.

6 Expansion Joints—A new 14-p. illustrated Bulletin No. 35-15B on the Adsco Piston-ring type, Model A expansion joint has been recently released. Details of construction, dimensions, specifications, etc., are given. The joint comes in sizes from 2-20 in. for all pressures up to 400 lb. American District Steam Co.

7 Steam Traps—Bulletin No. 450, is an 8 pp. booklet in color covering Sarco float-thermostatic steam traps, compressed air traps and liquid level controls. The bulletin includes illustrations of equipment, dimensions, capacities and price lists. Sarco Co., Inc.

8 Condensate Return System—The new Cochrane-Becker high pressure condensate return system for positive removal of condensate and complete elimination from entrained air from process equipment and return of condensate to the boiler at close to process temperatures is described in detail in a new 4 page bulletin, Publication 3025. Cochrane Corp.

9 Stokers—Catalog W, recently released, completely describes and illustrates the operations, advantages and applications of the Water-Cooled Taylor Stoker. American Engineering Co.

10 Coal Crusher—American "AC" type rolling ring crushers for reducing coal and other materials are described in an eight page bulletin which thoroughly illustrates the construction of the crusher with exterior views, views of parts and installations. A table of speed, capacity, horsepower and dimensions of the various sizes is also included. American Pulverizer Co.

11 Water Columns—Catalog No. 414 illustrates and describes Safety Water Columns and accessories for working steam pressures up to 250 lb. Dimension and selection tables, and diagrammed installation instructions are given. The Reliance Gauge Column Co.

12 Water Controls—Bulletins and leaflets have been issued dealing with Squires Automatic Boiler Feedwater Controller, Class B Excess Pump Governor and Air Traps. These devices are fully described, their applications and sizes are given. The C. E. Squires Co.

VALVES, INSTRUMENTS AND CONTROLS

13 Valves and Gages—Ashcroft gages, Hancock valves, American S & B instruments and Consolidated safety valves, with sizes, data, illustrations and price lists are covered in a new 44 pp. catalog. Manning, Maxwell & Moore, Inc.

14 Valves—Catalog No. 40 illustrates and describes various types of single seated valves for power plant, industrial and marine service. Included also are flanged combinations and dimensions. The Okadee Co.

15 Deaerator Control—Bulletin No. 29-34 describes the Brown Remote New-Matic Deaerator Control System which provides automatic control of the Air-o-Line type. Included are descriptions of the principles involved and application data. Schematic diagrams show how the system is hooked up for boiler operation. Brown Instrument Co.

16 Instruments—Priorities and Pyrometers is the title of a 6 p. Defense Bulletin No. 1, which gives a clear, concise explanation of how the national defense program affects purchase, use and maintenance of temperature measuring and control instruments. It suggests substitute materials that may be employed in place of materials made critical because of the war program, and compares the properties of the original and substitute materials. Wheelco Instruments Co.

17 Gages—8-p. booklet GEA-3673 describes electric gages available for measuring mechanical strains. In an interesting and easily understandable manner, this well-illustrated booklet describes the different types of gages available, and discusses their operation. General Electric Co.

18 Gages—The new 64-pp. Gage Catalog contains listings of numerous new gages, streamlined gage cases, gages for special services and a complete listing of Dura-Gauges. The catalog also illustrates the various gage testers and numerous accessories required by all gage users. Manning, Maxwell & Moore, Inc.

19 Instruments—A new catalog known as List CEC describes industrial models of analyzers, indicators and recorders that measure with laboratory accuracy. Recording gas analyzers, together with pH and other equipment for making precise measurements are featured. Cambridge Instrument Co.

ELECTRICAL EQUIPMENT

20 Motors—A new Bulletin RS-60 describes the Howell modern protected type motors. Thoroughly illustrated the bulletin also includes application and construction qualities. Howell Electric Motors Co.

21 Protective Lighting—Dealing with the present and urgent need for protective lighting around industrial plants, folder, No. 101, on Plant Floodlighting illustrates various styles of porcelain enameled floodlights available, and introduces a new fixture known as the Elipso Standlite. Goodrich Electric Co.

22 A. C. Generators—For use in municipal lighting plants and for industrial emergency power, large a.c. generators of from 25 to 2180 kv-a. for Diesel engine drive are described in a new 16-p. Bulletin B 3028. Rotor and stator constructions are discussed, electrical auxiliaries described and the Silverstat regulator which replaces the vibrating type is discussed in some detail. Westinghouse Electric & Mfg. Co.

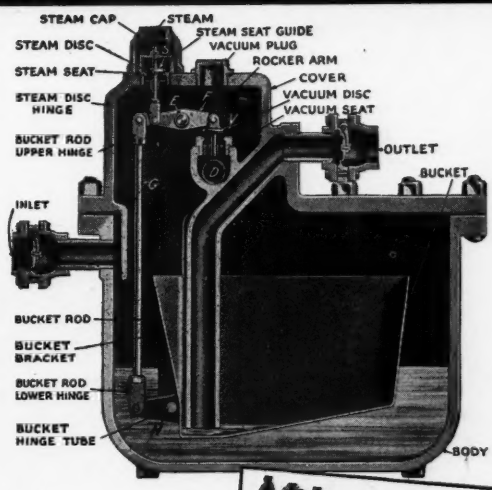
MISCELLANEOUS

23 Pipe Tools—This general catalog covers a complete line of portable pipe and bolt cutting and threading machines; portable pipe and bolt cutting and threading power drives and pipe tools from ⅛ to 12-in.; pipe reamers; vises; sawing vises; grooving and beveling tools and threading oil. Beaver Pipe Tools, Inc.

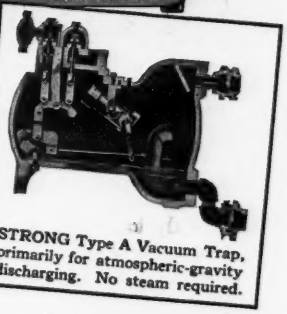
24 Vacuum Cleaners—Industrial and commercial vacuum cleaners are described in a recently released 8-p. Form No. 108 with descriptive data on heavy duty cleaners for all around use, the quiet zone model where silence is essential and the Hercules model which handles sludge and dirt in large quantities. Doyle Vacuum Cleaner Co.

PIPEWRENCH PETE SAYS:

THIS TRAP MAKES LIQUIDS RUN UPHILL!



ABOVE: Strong Type M Trap removes liquids from a vacuum or low pressure and discharges to point higher than trap or against back pressure. Uses steam, air or gas only in equal volume to liquid removed.



STRONG Type A Vacuum Trap, primarily for atmospheric-gravity discharging. No steam required.

PLENTY OF SPECIAL FEATURES IN THESE POSITIVE-ACTING, TROUBLE-FREE TRAPS

It's no cinch to lick drainage problems like those you find in condensing engine exhaust lines, vacuum heaters, sump holes and the like. But STRONG has the right answer to all of 'em in these two traps for vacuum, lifting and pumping service—and built to handle water, oil or gasoline.

You'll find lots of smart engineering in 'em to help you do a better job and save the plant important money!

For complete details on this equipment, plus tips on making vacuum or lifting systems work better, get Catalog 64-PPE6 on STRONG Vacuum and Lifting Traps. No obligation, so drop a card now to . . .

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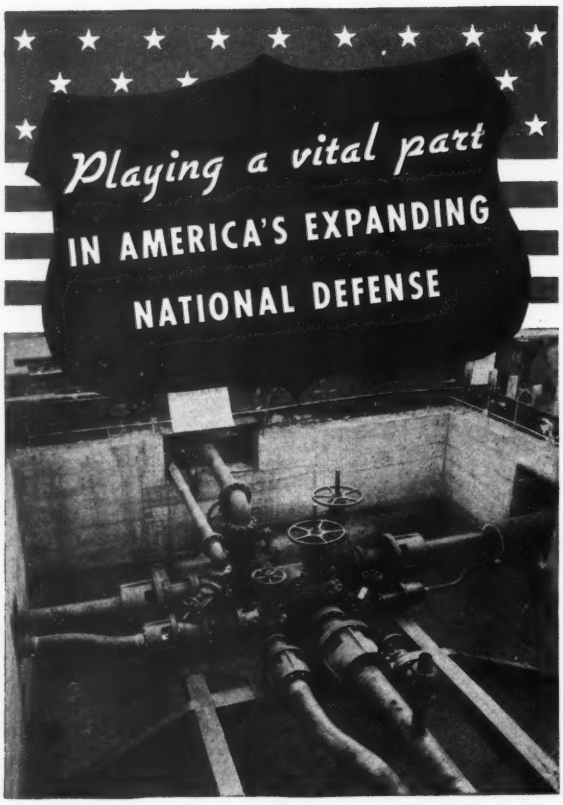

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25 **Industrial Products**—The new 52-p. 1942 edition of the Johns-Manville Industrial Products Catalog contains information and recommendations on high and low temperature insulations for industrial needs from 400 deg. F. below zero to 2500 deg. F. above. Data are included on refractory products, roofing and siding, friction materials, electrical insulating materials, Transite Pipe packings, gaskets and industrial flooring. Johns-Manville.

26 **Conveyor**—Recently released 16-p. Bulletin No. 410 gives detailed information and pictorial descriptions of the Rex Belt Conveyor, Apron Conveyors and Bucket Elevators. Chain Belt Co.

27 **Materials Handling**—Engineering and Application Data is the title of recently released 12-p. bulletin dealing with overhead materials handling equipment. Included with illustrations are descriptions of cranes, transfer bridges, switches, hoists, carriers and various other equipment of the Cleveland Tramrail systems. The Cleveland Crane & Engineering Co.

28 **Shovel**—The Link-Belt Speeder LS-60 heavy-duty ½ yd. crawler shovel, dragline, crane is covered by a new 8-p. illustrated Book No. 1929. Simplicity, reserve power, easier handling, all welded construction, are featured. Illustrations show the machine at work and its construction. Working ranges, lifting capacities, clearance dimensions and other pertinent data are also included. Link-Belt Speeder Corp.

29 **Laminated Shims**—A new 8-p. booklet gives a history of the development of industrial and mechanical applications of the laminated shim since the founding of the company. The book also describes the use of the shim for fitting of machine parts in original assembly, as well as for making service adjustments. Laminated Shim Co.

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31 **Tires**—The Operator's Handbook is a timely booklet on how to obtain maximum service life from truck tires. Included are charts and tables portraying the value of proper inflation and loads, and dangers in over- and under-inflation, mis-matching of dual tires, causes of uneven tread wear, and the effect of overloads and excessive speeds. B. F. Goodrich Co.

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32 **War Work**—How Small Industries Can Go After War Work is the title of an illustrated booklet recently published to show small companies how to go after contracts or subcontracts through the Contract Distribution Branch, Production Division, War Production Board, Washington, D. C., or through its Regional Offices in many cities in each state. Copper & Brass Research Association.

SPECIAL REQUEST BULLETINS

Drills—A 32-p. booklet entitled Drill and Reamer Facts describes and illustrates the design and construction of twist drills, and suggestions in the proper use and care of drills and reamers. The booklet is distributed free to individuals when requested on company letterhead. Whitman & Barnes, Div. of United Drill & Tool Corp.

Piping—Bulletin No. 420A gives technical data and engineering information covering the design and construction of Unit Systems for underground steam piping. It is a reference manual designed to be of practical assistance to those concerned with the layout and purchase of underground and overhead steam line construction. It will be sent without charge to those persons connected in an engineering and planning capacity with military, naval, aeronautical and other war construction projects, or with industrial plants built for or converted to war facilities. The Ric-Wil Co.

New Engineering Books

Shipbuilding Terms. Compiled under the supervision of Fred C. Williamson. Published by the American Technical Society, Drexel Ave. at 58th St., Chicago, Ill. Size 5 by 7 in., 64 pp., spiral paper binding. Price 50 ct.

This book is intended to give the thousands of new employees in shipbuilding yards throughout the country a clear and easy-to-understand definition or explanation of each of the many ship terms, and to acquaint them with ship locations and abbreviations of ship terms. These definitions, locations and abbreviations apply to tankers, cargo vessels, destroyers and mine sweepers.

It is arranged for use by individuals for self-study and contains several assignment sheets which will prove very useful for both self-study and class work. There are 3 pp. of true-false test questions so the reader and student can check himself to see how thoroughly he has mastered the definitions. In addition there is a completion or final test.

It was prepared under the supervision of Fred C. Williamson, Assistant State Supervisor, Trade and Industrial Education, Alabama State Department of Education, by the Field Service, Department of T. and I. Education, University of Alabama, in cooperation with the Mobile Public Schools, the Alabama Drydock & Shipbuilding Co. and the Federal Security Agency.

Standards on Copper and Brass Alloys. Published by the American Society for Testing Materials, 260 So. Broad St., Philadelphia, Pa. Size 6 by 9 in., paper bound, 344 pp. Price $2.00.

This new publication provides in convenient form for ready reference the various specifications and tests issued by the Society covering copper and copper base products, cast and wrought products and copper and copper alloy wires for electrical conductors. There are some 73 standards covering a wide range of very important products, many of which are essential in the present National emergency program.

Twelve of the 73 specifications cover various types of wire and cable for electrical conductors; sixteen cover various types of plate, sheet, and strip, including cartridge brass, gilding metal, gilding metal bullet jacket cups, bridge bearing and expansion plates, phosphor bronze, beryllium-copper materials, and Muntz metal; and mine various types of copper and brass boiler tubes, standard pipe, copper seamless tubes and water tubes. Among the standard tests are: the new expansion (pin test) test for tubing; the mercurous nitrate test for copper alloys; standard tension and hardness tests; the extensive methods of preparing micrographs of metals and alloys, with the insert plate showing grain size standards.

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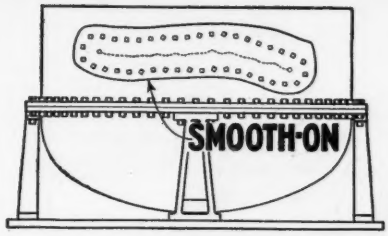

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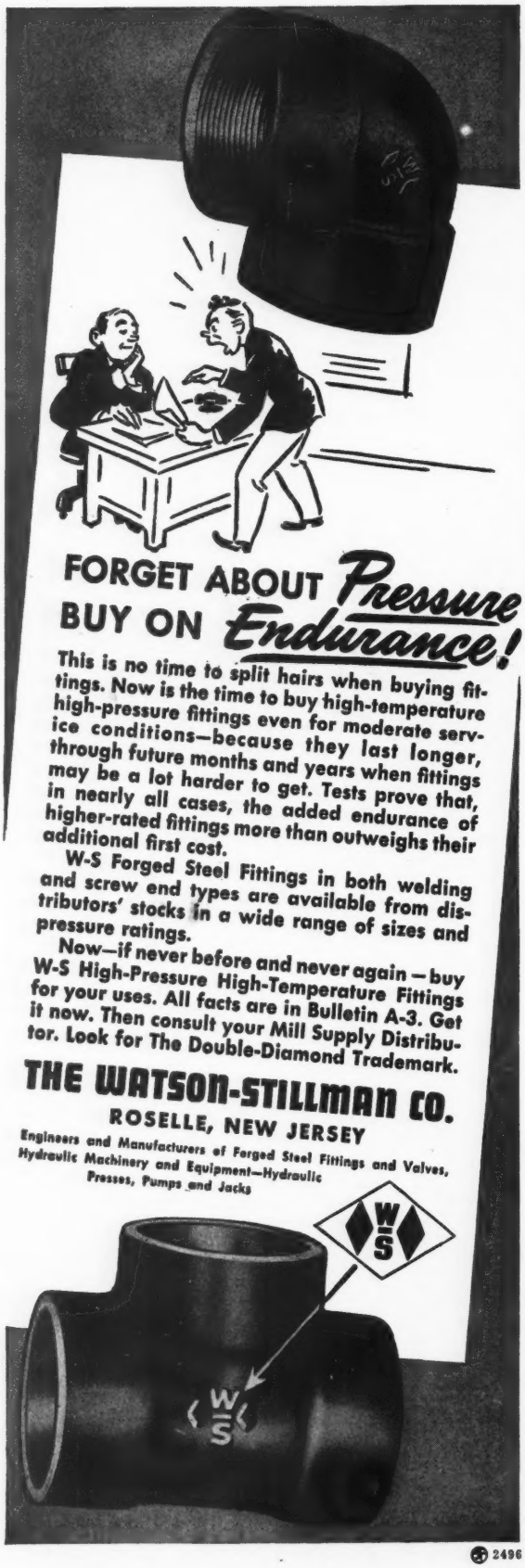
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Handbook of Chemistry and Physics. Editor in Chief, Charles D. Hodgman. Published by the Chemical Rubber Publishing Co., 1900 West 112th St., Cleveland O. Copyright 1942, 25th edition, 2521 pp., size 5 by 7 in., semi-flexible Fabrikoid binding. Price $3.50 in U. S., $4.00 in foreign countries.

The Handbook of Chemistry and Physics is revised annually to keep pace with research work and extensive changes have been made in recent years. Starting with the 1939 edition and including the current issue, more than half the pages in the book have been added or completely revised and reset.

In many ways it is a most amazing book. Probably no book published gives so much for so little. Its 2500 pp. are crammed with the concentrated knowledge accumulated through countless years of effort by thousands of scientific workers. Nearly all of this knowledge is presented in the form of tables, most of which have been compiled especially for the handbook. The book includes material on all branches of chemistry and physics and the closely allied sciences.

Many mathematical tables are included and in this new edition additional conversion tables are given. The material on vitamins has been revised to harmonize with recent changes in this field and the table of isotopes has been reset to conform with latest research developments. The table of photographic plate and film speeds, which is one of the most complete to be found anywhere, has been revised.

It is impossible in a short review to give anyone who has never seen this book an adequate conception of its vast scope but it is a book that belongs in the reference library of every engineer and scientist.

Training Oxy-Acetylene Welding and Cutting Operators—Instructors Outlines. Published by the International Acetylene Assn., 30 East 42nd St., New York, N. Y. Price: paper bound 25 ct.; de luxe edition, cloth bound, 75 ct.

The book was prepared primarily to assist instructors in planning courses for the training of oxy-acetylene welding and cutting operators. Divided into three chapters, the first outlines the essential information that should be presented in a course for the training of specific welding jobs; the second is an outline form of material essential to the training of various types of cutting operators, and the third outlines the essential information that should be given in a course for inspectors.

The material presented has been divided into self-contained units, each of which includes the four essential parts of any particular lesson, namely, an outline for a classroom lecture, suggestions for study assignments, recommendations for the material that should be demonstrated and discussed, and a description of the practice exercises the student should do in the shop.

How Inventors Can Aid National Defense. Prepared as Information Bulletin No. 2 for the National Inventors Council, U. S. Dept. of Agriculture and for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C. This 22 p. booklet outlines the purpose of the Council, the character of inventions needed, suggested procedure for submitting inventions and suggested literature for those not familiar with military requirements and present developments in the field.

Practical Arc Welding. By W. J. Chaffee. Published by Hobert Trade School, Inc., Troy, O. First edition, copyright 1942, with 516 pp. and 512 illustrations, size 5¾ by 8¼ in., flexible red Fabrikoid binding. Price $2.00.

This book was prepared to assist in the development of welders to fill the unprecedented demand for such workers today. Part 1 is devoted to general welding information. The material includes the growth of arc welding; where welding is used; manufacturing applications; available metals and alloys; discussion of joints and welds; electrodes and filler rods; strength of the arc welded joint; cost of arc welding; welding symbols and their use; equipment for arc welding, and the development of welding personnel.

Parts 2 and 3 are devoted to the complete series of arc welding lessons exactly as they are offered in the Hobart Trade School. Parts 4 and 5 contain a complete dictionary of welding terms and 20 pp. of helpful tabular data for operators and designers. While easily comprehensible to beginners, the book contains a wealth of practical arc welding information for the technical man.

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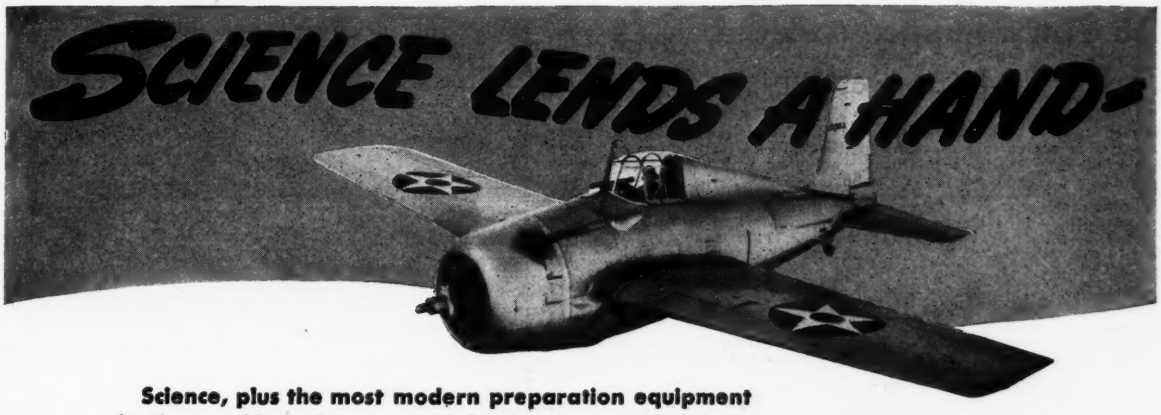

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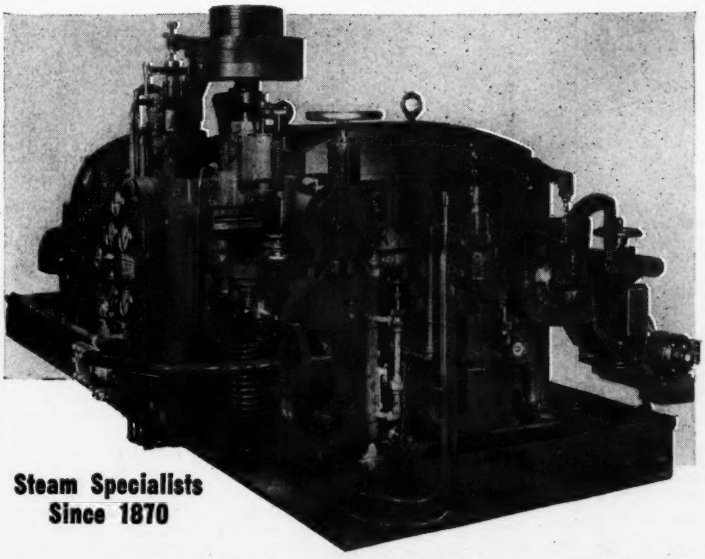

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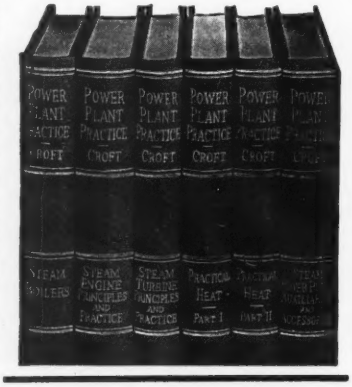

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Experimental Physics. By D. H. Bellamy. Published by Chemical Publishing Co., 234 King St., Brooklyn, N. Y. Copyright 1941, First edition, 256 pp., size 5 by 7½ in., cloth. Price $3.75.

This book is intended to serve as a guide for students in conducting actual physical experiments. Through the comprehensive set of experiments outlined the student should be able to gain a practical as well as theoretical knowledge of the fundamentals of physics. In all 200 different experiments are described with detailed instructions for their operations. After a short introduction the volume is divided into six major parts, listed as follows: 1, Heat. 2, Light. 3, Sound. 4, Magnetism. 5, Electricity. 6, Properties of Matter. The author is Senior Physics Master at the Normanton Grammar School and Lecturer in Physics and Engineering Mathematics at the Whitwood Mining and Technical Institute both in England.

Modern Sanitary Engineering. Published by Chemical Publishing Co., 234 King St., Brooklyn, N. Y. Copyright 1942 with 169 pp., and 96 illustrations, size 5½ by 8½ in., cloth bound. Price $5.00.

This book, according to the author's preface, is intended to show how the latest developments of sanitary science are applied in the field of Sanitary Engineering. Much of the information is the result of considerable practical experience in designing and erecting buildings of a varied nature and the examination of unsanitary buildings. The subject is treated from foundations to the completion of a building with special reference to the drainage and water supply. Wherever practicable illustrations have been used to convey as much information as possible so as to reduce the amount of printed matter and to avoid the tedious labor of continually referring to the text.

The book should prove useful both to the experienced engineer and to those who approach the subject for the first time. Certain information has been included, not only because it is likely to be of interest to the general reader, but also because a knowledge of sanitary science is frequently required by candidates preparing for the examinations of recognized technical institutions. The author is English and the book of course reflects the English point of view but the book should be of considerable interest to those interested in the subject in this country.

Wartime Building Construction. Published by Chemical Publishing Co., 234 King St., Brooklyn, N. Y. First American Edition, 1942, 148 pp., size 5½ by 8½ in., cloth bound. Price $4.00.

This book reprinted in this country by special permission of the controller of His Brittanic Majesty's Stationery Office, reviews the general principles of wartime building as conducted in England. It is an interesting little book and it should be of considerable value in this country now engaged in wartime expansion work. As might be expected, it stresses the degree of fire protection required and the best means for carrying out the work. There is a special section devoted to the construction of single story buildings to provide living quarters for armed forces, also for temporary office accommodations and hospitals.

A planned economy in the use of building materials is necessary in wartimes to conserve steel. Therefore in the sections of this book devoted to the methods used for the application of reinforced concrete construction and also the means of constructing arches without the use of centering, are especially significant. Because it is up to date in the light of present day British experiences, the book has special value in this country at the present time.

Electric Relays. By J. Rosslyn. Published by Chemical Publishing Co., 234 King St., Brooklyn, N. Y. Copyright 1941, first edition, 184 pp., size 5¾ by 8½ in. cloth. Price $2.50. Price $2.50.

This book brings together technical knowledge on the widely varying types of electric relays ranging from the simplest magnetic relay to the most complex types of gas-filled and photoelectric relays. Although the book is written from the English point of view, the principles discussed apply equally well to equipment of all makes and the book should prove as valuable in this country as it is in England. Constructional details and notes are given on the use of magnetic relays used for the control of bells and signalling systems, emergency lighting, pump and fan control while the subject of photoelectric relays has received especial attention. A special chapter has been devoted to the thermionic, or gas-filled relays which are used in the control of modern welding equipment. Many circuit diagrams are included. It is a good book for the beginner.

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Power Plant Construction News

Conn., Bristol—Board of Directors, Bristol General Hospital, plans expansion in boiler plant for central-heating service in connection with a new multi-story hospital addition. The entire project will cost close to $560,000. Bids are scheduled to be asked soon on erection contract. Charles S. Palmer, 75 Whitney Avenue, New Haven, Conn., is architect.

Ill., Decatur — Illinois-Iowa Power Co., Monticello, Ill., is considering a new steam-electric generating station on Illinois River, near Decatur. Details of equipment installation are being arranged. No estimate of cost announced.

Ill., North Chicago—Fansteel Metallurgical Corp., North Chicago, manufacturer of metal alloys, chemical products, etc., plans installation of electric power equipment in new 2-story addition, for production of equipment for the Government. Work will be placed under way soon. Cost reported about $5,000,000, with financing in that amount to be provided by Defense Plant Corp., Washington, D. C.

Ind., Decatur — Light and Power Department, City Hall, plans alterations and improvements in municipal power plant, including modernization of boilers, stokers, etc. Cost to be about $65,000. Proposed to ask bids soon. Froehlick & Emery Engineering Co., Second National Bank Building, Toledo, Ohio, is consulting engineer.

Ind., Fort Wayne — Light and Power Department, 308 East Berry Street, plans expansion and improvements in municipal power plant on North Clinton St., including installation of new boiler unit and other equipment. Cost is reported to be about $200,000.

Iowa, Des Moines—Iowa Packing Co., a subsidiary of Swift & Co., Union Stock Yards, Chicago, Ill., has approved plans for new 6-story addition, about 80 by 125 ft., to be equipped primarily as a cold storage and refrigerating plant. Cost is to be about $185,000, with equipment. Work will begin at early date.

Md., Fort Howard — Construction Service, Veterans' Administration, Washington, D. C., will receive bids until March 17 for a new boiler house at the institution at Fort Howard, including 150-ft. radial brick stack, boilers and complete auxiliary equipment, as per plans and specifications on file at office noted.

Mich., Dearborn—Ford Motor Co., Dearborn, plans installation of electric power equipment in two new additions at River Rouge plant, each one-story, about 230 by 1100 ft., and 100 by 440 ft., respectively, to be used for armor plate production and for expansion in steel mill, in order noted. The entire project is reported to cost over $5,000,000. Work will begin at once. Shreve, Anderson & Walker are architects for first mentioned structure, and Giffels & Vallet, architects and engineers for last noted, both Marquette Building, Detroit, Mich.

Mich., Hillsdale—Board of Public Works, Hillsdale, is considering extensions in municipal power plant, with installation of a new turbine-generator and accessory equipment. Cost is reported to be over $75,000. Details will be arranged at an early date.

Minn., Milaca — Land o' Lakes Dairy Co., a subsidiary of Land o' Lakes Creamery, Inc., Minneapolis, Minn., plans a power house at the new milk dehydration plant at Milaca, with installation of generator unit, boiler and auxiliary equipment. Also will install electric power equipment in main one and 3-story plant, about 65 by 128 ft. The entire project will cost about $150,000. Work will begin soon. Max O. Buetow, 1931 University Avenue, St. Paul, Minn., is architect.

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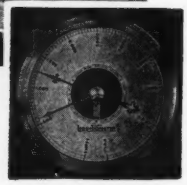

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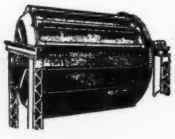

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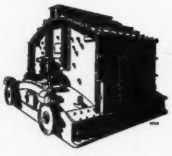

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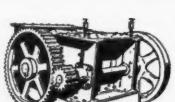

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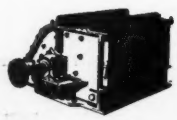

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N. Y., Corona—Board of Education, City of New York, 49 Flatbush Ave. Extension, Brooklyn, plans a boiler plant for central-heating service in the new vocational high school at Corona. Cost is estimated to be over $2,500,000, with equipment. Work is scheduled to begin soon. Architectural Department of Board, address noted, is in charge.

N. D., Harvey—Otter Tail Power Co., Fergus Falls, Minn., plans expansion and improvements in steam-electric power plant in the vicinity of Harvey, with the installation of a new 5000-kw. turbine-generator and auxiliary equipment. Work to have unit ready for service before the close of this year has been proposed. No estimate of cost has been announced.

Ohio, Bellaire—Ohio Public Service Co., Hanna Bldg., Cleveland, Ohio, is considering plans for a new steam-electric generating station on Ohio River at Dilles Bottom, vicinity of Bellaire. Cost is reported to be over $6,500,000, including transmission lines, switching station and other facilities. Application for permission has been made.

Ohio, Cleveland—Cleveland Electric Illuminating Co., has arranged a fund of about $16,278,000 for expansion and improvements in plants and system during 1942, including generating stations, power substations, transmission and distributing lines. Work will include installation of new 72,000-kw. turbine-generating unit and auxiliary equipment at the local Lake Shore generating plant, as well as expansion at the Avon Lake power station, previously noted in these columns, where a 100,000-kw. generating unit with accessories, will be installed.

Ohio, Youngstown — Republic Steel Corporation, Republic Building, Cleveland, Ohio, plans power plant at mill at Youngstown, where works are being expanded for production for Government. New station is reported to cost over $2,000,000 with turbine generators, boilers and auxiliaries. United Engineers & Constructors, Inc., 1401 Arch Street, Philadelphia, is engineer.

Pa., Pittsburgh—Dravo Corp., Neville, Island, manufacturer of heavy machinery and parts, plans installation of electric power equipment in connection with expansion in its plant, comprising about 15 new one-story shops and other structures. Entire project is reported to cost close to $5,000,000.

Texas, Texas City—Southport Petroleum Co., Inc., Houston, plans a boiler house and pumping station at the new refining plant in the vicinity of Texas City, for production of high-octane gasoline for aircraft service. The entire project is reported to cost over $3,500,000. Output will be used by the Government, with financing to be provided by Defense Plant Corp., Washington, D. C.

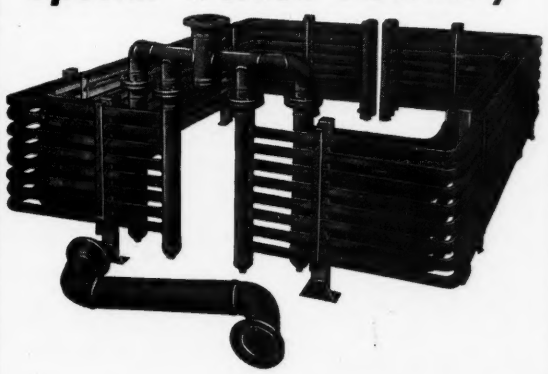
Utah, Salt Lake City — Kalunite, Inc., a subsidiary of F. W. Olin Corp., East Alton, Ill., plans installation of electric power equipment in the new plant in vicinity of Salt Lake City, for production of alumina for the Government. It will comprise several large one and multi-story buildings, equipped for processing and general production. A power substation will be built, as well as a boiler house for mill service. Entire project will cost close to $3,000,000, with financing to be provided by Defense Plant Corp., Washington, D. C.

W. Va., Parkersburg — Corning Glass Works, Inc., Corning, N. Y., manufacturer of technical and industrial glass products, plans installation of power equipment in a new branch plant in the vicinity of Parkersburg. It will consist of several one and multi-story units, with machine shop, boiler house and auxiliary structures. The entire project will cost close to $3,000,000. Output will be for the Government, with financing to be provided by Defense Plant Corp., Washington, D. C.

Wis., Green Bay—Hurkman's Meat Market has approved plans for a new one-story and basement cold storage plant on adjoining site, about 40 by 60 ft. Work is scheduled to begin at once. Robert Surplice, City Center Building, is architect.

Wis., Green Bay—Wisconsin Public Service Corp., Milwaukee, plans further expansion in Bayside steam-electric generating station at Green Bay, with work to begin closely following present extensions, now in progress, previously referred to in these columns. The new program will include installation of a 30,000-kw. turbine-generator and auxiliary equipment, boiler unit, etc., with cost reported close to $2,750,000. Application has been made for permission. Public Utility Engineering & Service Corp., 231 South LaSalle Street, Chicago, Ill., is consulting engineer.

Special Welded Assembly



● Above illustration shows special welded assembly and supply-header by Rempe.

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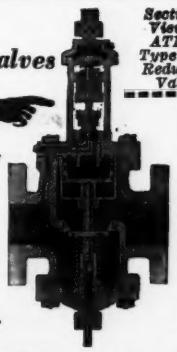

Sectional View of ATLAS Type "A" Reducing Valve

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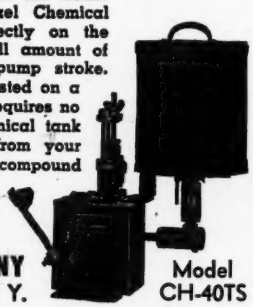

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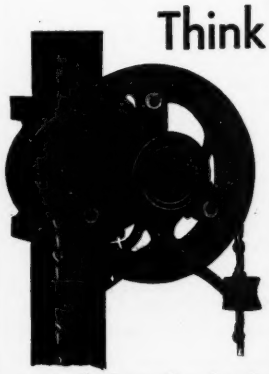

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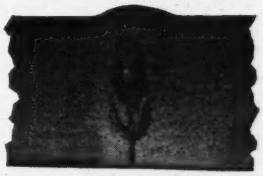

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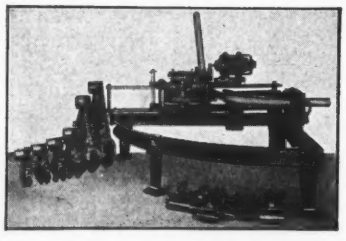

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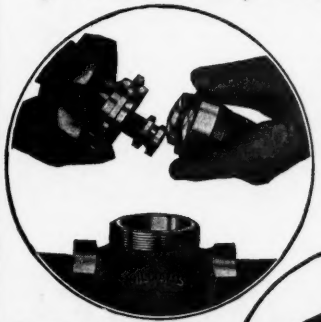

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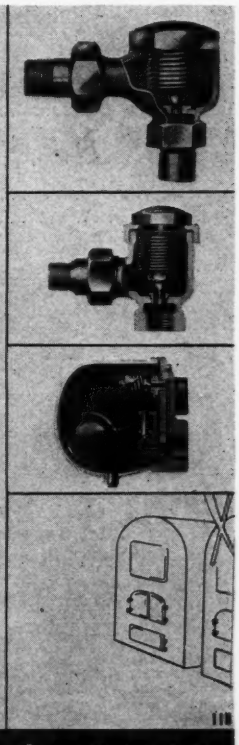

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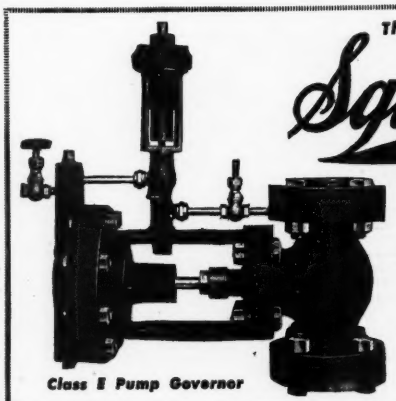

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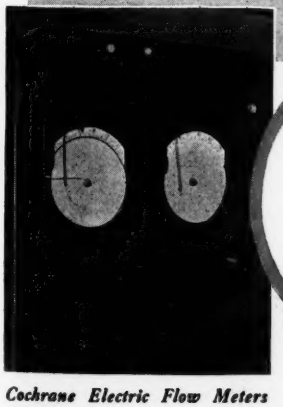

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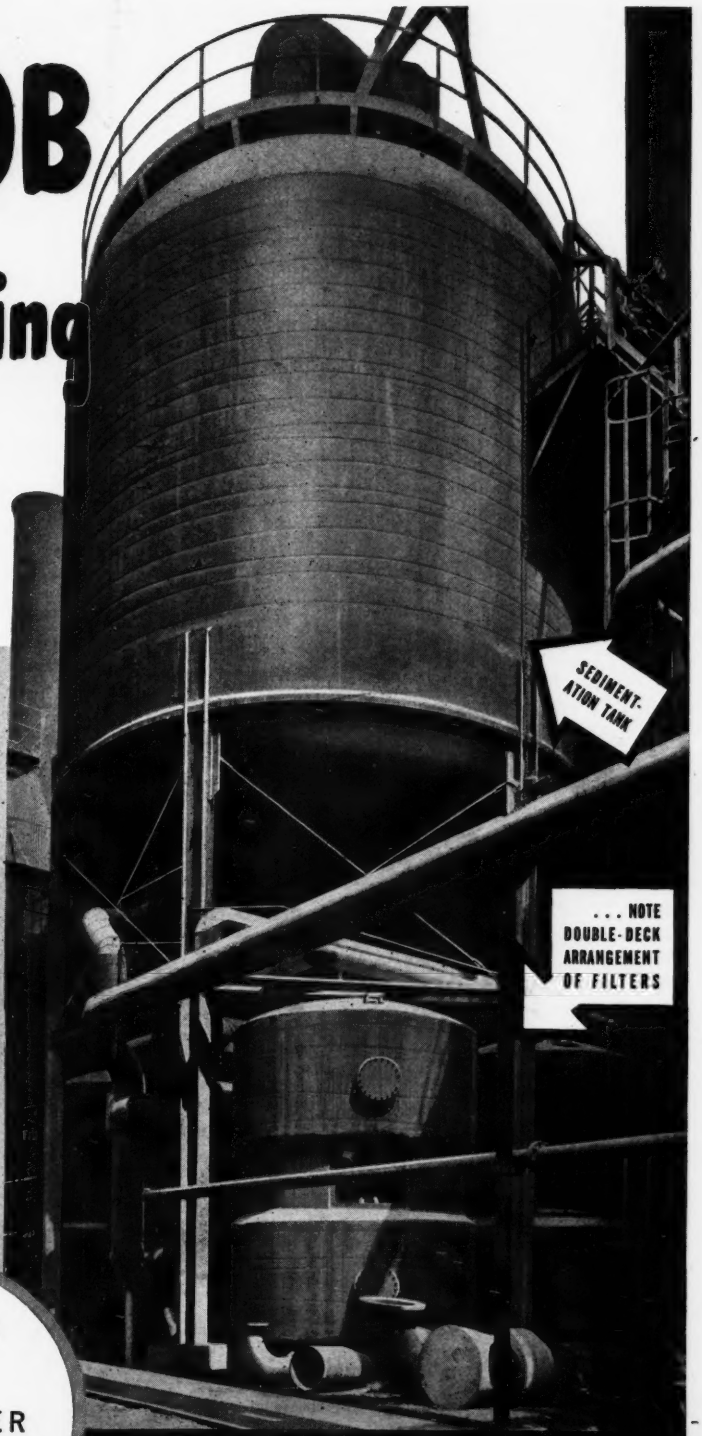

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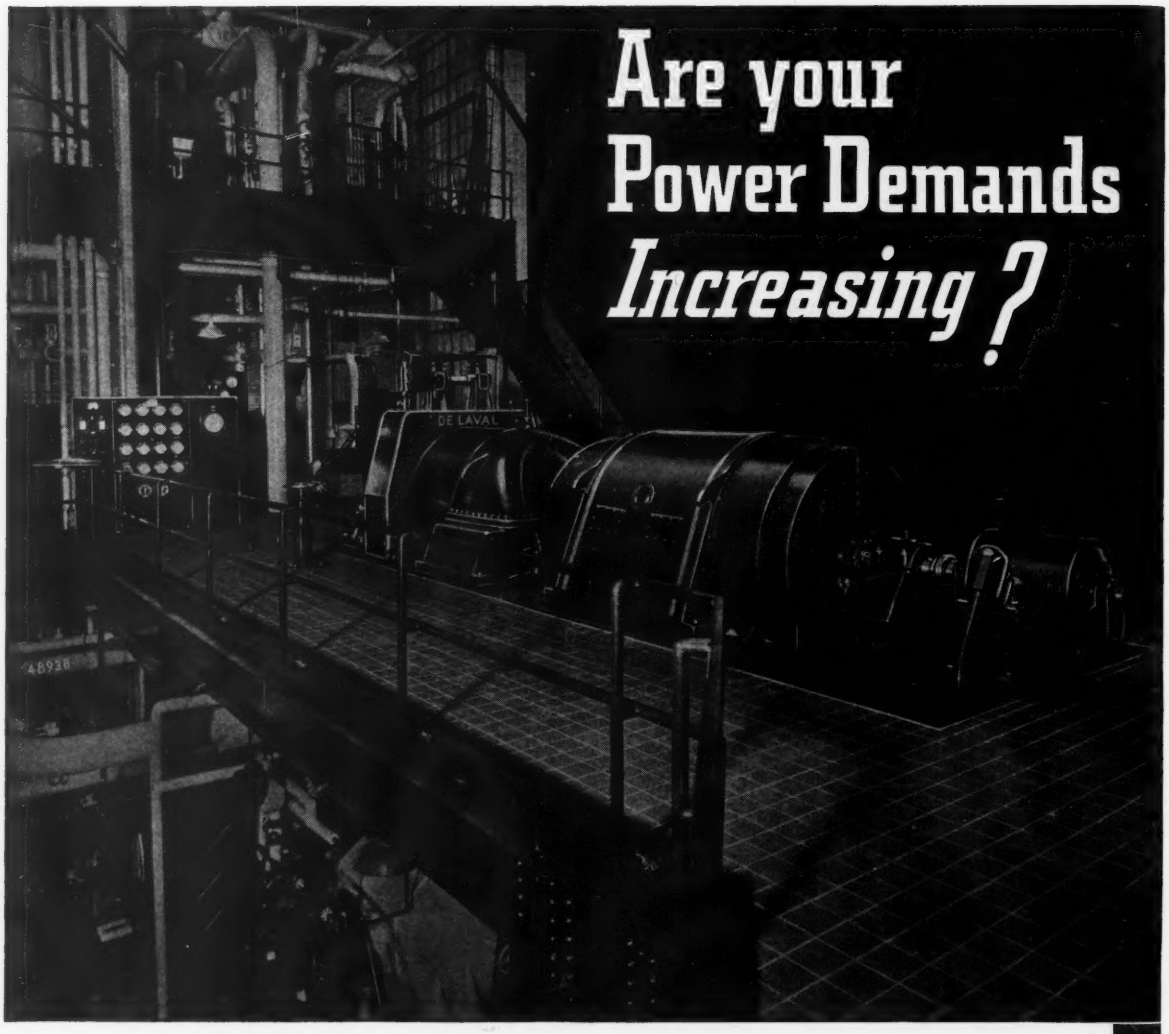

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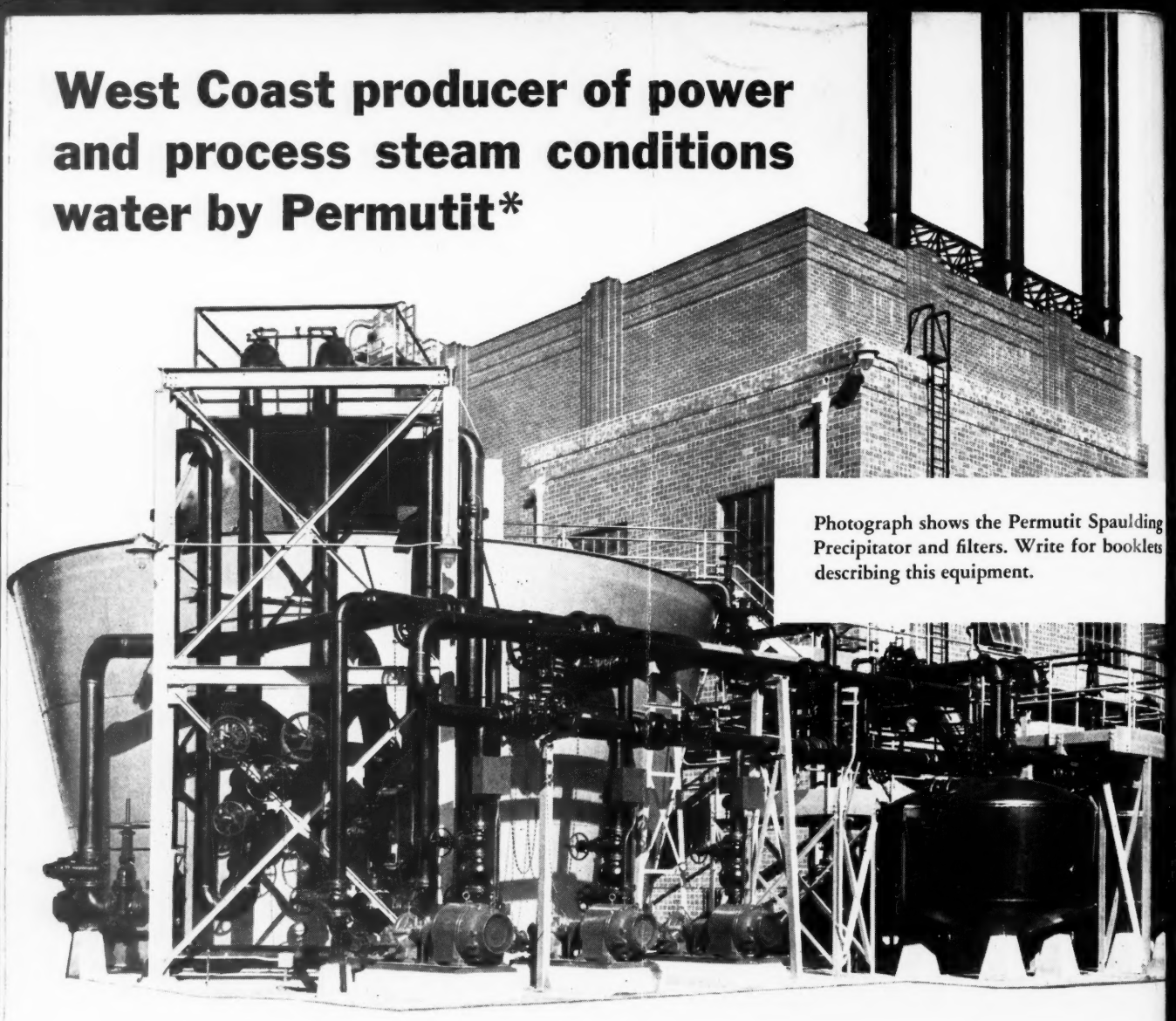

Photograph shows the Permutit Spaulding Precipitator and filters. Write for booklets describing this equipment.

★ This is an interesting plant. Power is produced by 1500 psi. boilers which operate a turbine. Steam is extracted from a stage in the turbine, whence it goes to four evaporators which produce process steam at 150 psi. The high pressure boilers are fed condensate from the evaporators and surface condensers.

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